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Founded by HENRY BALDWIN WARD
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Program and Abstracts of the 53rd Annual Meeting, American Society of Parasitologists, Philadelphia, Pennsylvania October 30, 31, November 1, 2, 1957.

Copies of this issue will be available at Philadelphia

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THE JOURNAL OF PARASITOLOGY

The Journal of Parasitology, published bi-monthly, is the official organ of the American Society of Parasitologists and as such it publishes the program of the annual scientific meeting, abstracts of the papers presented there, and minutes of the business meetings of the Society.

The Journal of Parasitology is a medium for the publication of the results of research in the field of animal parasitology. Manuscripts dealing with subjects in this field will be considered for publication, and accepted manuscripts will be published in order of receipt. A manuscript is accepted with the understanding that it is to be published exclusively in the Journal unless otherwise arranged in advance.

Articles submitted for publication may be sent to any member of the Editorial Committee or Editorial Board. Responsibility for acceptance of papers is divided in the Editorial Committee for the fields of helminthology, protozoology and entomology. Correspondence concerning the disposition or revision of manuscripts should be addressed to Leon Jacobs, Chairman of the Editorial Committee, Laboratory of Tropical Diseases, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda 14, Maryland.

Manuscripts submitted should be typewritten, double or triple spaced, with wide margins, and with tables, graphs, and illustrations in finished form for transmission to the printer. Title, author, institution, etc., go on a separate sheet. Each table requires a separate sheet. Footnotes are not encouraged. Such material can usually be embodied in the text. If footnotes are used, they should be numbered consecutively and typed on a sheet separate from the text. Authors are urged to emphasize simplicity and clearness in tables. When feasible, sharp, contrasty photographic reproductions of large plates and graphs should be submitted in place of the originals. In preparing plates care should be given to the effective arrangement of figures, to economy of space, and to the amount of reduction required. Figures should be arranged within an area five by eight inches, or multiples thereof. Legends for figures should be typed on a sheet, separate from the text, and containing no illustrations. Greek characters and symbols should be avoided, where possible, since they require hand composition, thus increasing the cost of publication.

The bibliography, double or triple spaced, should contain only those references actually cited in the text, and its style should conform to bibliographies in recent issues of the Journal. The Index Catalogue of Medical and Veterinary Zoology should be used as a guide for abbreviating the journals cited.

Since it is the desire of the Editorial Committee to publish all acceptable manuscripts submitted within the limited space available, authors are urged to present their results briefly, avoiding tables where possible. However, acceptability of a paper will be determined not by its length but by the amount and character of new information included and the form in which it is presented. Long articles, and those with an unusual number of tables and plates, can be published only with the financial cooperation of the author.

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PROGRAM AND ABSTRACTS OF THE THIRTY-SECOND ANNUAL MEETING OF THE AMERICAN SOCIETY OF PARASITOLOGISTS

PHILADELPHIA, PENNSYLVANIA

October 30, 31, November 1, 2, 1957

NOTE: Registration: Wednesday through Saturday. Get Luncheon Tickets at Time of Registration.

PROGRAM[1]

Wednesday Afternoon Session A, October 30, 2:00 P.M.
Betsy Ross Room, Benjamin Franklin Hotel

Allen McIntosh, USDA, PRESIDING

Read

1. Notes on further studies of the inheritance of resistance to trichostrongylidosis in sheep. (8 min.) (Standard lantern). **J. H. Whitlock** and **H. Madsen,** Cornell University.

2 Preliminary studies on trichostrongylids in sheep by means of a gastric pouch. (7 min.) (Standard lantern). **J. H. Whitlock** and **H. Madsen,** Cornell University.

3. Studies on the effect of X-rays on the infective stage of the nematode, *Trichostrongylus axei.* (12 min.) (2×2 lantern), (Standard lantern). **H. Ciordia,** ARS, USDA.

4. The effect of green feed upon the development of *Trichostrongylus axei* in the laboratory rabbit. (10 min.) (Standard lantern, 2×2 lantern). **G. H. Rohrbacher, Jr.,** ADP, ARS, USDA.

5. The experimental infection of swine with nematodes of ruminants. (10 min.) (Standard lantern). **F. G. Tromba** and **F. W. Douvres,** ARS.

6. The effect of the nematode, *Trichostrongylus axei* (Cobbold, 1879) on the utilization and excretion of certain elements. (15 min.) (Standard lantern, 2×2 lantern). **R. F. Shumard,** North Dakota Agricultural Experiment Station.

7. Further studies on ovine strongyloidiasis: An attempt to induce passive immunity. (12 min.) (Standard lantern). **J. H. Turner,** ARS, USDA.

8. Parasitism, parthenogenesis and polyploidy: The life cycle of *Strongyloides papillosus.* (15 min.) (Standard lantern, 2×2 lantern). **P. C. H. Chang** and **G. L. Graham,** University of Pennsylvania.

9. Preliminary observations on the life history of the sheep pinworm, *Skrjabinema ovis.* (15 min.) 2×2 lantern). **G. A. Schad,** ARS, USDA.

10. Preliminary experiments on transmission of gastrointestinal nematodes of ovine and caprine origin to lambs and kids on pasture. (12 min.) (Standard lantern). **G. I. Wilson** and **K. C. Kates,** ARS, USDA.

11. Observations on the relationship of serum protein changes, antibody formation, and eosinophilia in cattle infected with the lungworm, *Dictyocaulus viviparus.* (15 min.) (Standard lantern, 2×2 lantern, and opaque projector). **T. B. Weber,** ARS, USDA.

[1] An alphabetical author-index will be found at the end of this section of the program. Extra copies of this Supplement will be on sale at the meeting.

12. Problems of nematode control in the captive giraffe and okapi. (12 min.) (Standard lantern, 2×2 lantern). **B. J. Jaskoski,** Loyola University (Chicago) and Chicago Zoological Park.

13. Host specificity of *Nippostrongylus muris.* (15 min.) (Standard lantern). **A. J. Haley,** University of Maryland.

Wednesday Afternoon Session B, October 30, 2:00 P.M.
Franklin Room, Benjamin Franklin Hotel

Gilbert F. Otto, Abbott Laboratories, PRESIDING

Read

14. Isolation of *Trypanosoma cruzi*-like organisms from wild animals collected in Georgia. (10 min.) (Standard lantern, 2×2 lantern). **M. M. Brooke, L. Norman, D. Allain,** and **G. W. Gorman,** Communicable Disease Center.

15. Respiration of *Trypanosoma cruzi* during *in vitro* growth. (10 min.) (Standard lantern). **L. G. Warren,** Johns Hopkins University.

16. Studies on the properties of anti-*Trypanosoma cruzi* factors in chicken sera. (5 min.) (Standard lantern). **T. Borsos** and **L. G. Warren,** Johns Hopkins University.

17. Antigenic relationships of certain hemoflagellates as determined by the Ouchterlony gel diffusion technique. (10 min.) (Standard lantern). **D. V. Moore,** University of Texas, Southwestern Medical School.

18. Some considerations on the nature of immunity of rats to *Trypanosoma lewisi.* (10 min.) (Standard lantern). **A. C. Chandler,** Rice Institute.

19. The prophylactic action of a sulfonate salt of quaternary bisquinaldines against *Trypanosoma congolense* in white mice. (15 min.) (Standard lantern). **G. F. Otto, J. C. Moetsch,** and **R. U. Schock,** Abbott Laboratories.

20. A comparative study of experimental leishmaniasis in the mouse, Mongolian gerbil, hamster, white rat, cotton rat, and chinchilla. (15 min.) (Standard lantern). **J. Grun** and **L. A. Stauber,** Rutgers, The State University of New Jersey.

21. Study of the exoerythrocytic stages of *Plasmodium gallinaceum* and *P. fallax* in tissue culture by phase contrast microscopy. (15 min.) (Standard lantern). **C. G. Huff, A. C. Pipkin,** and **D. V. Jensen,** Naval Medical Research Institute.

22. The effect of temperature of the host on the course of infection of *Plasmodium cathemerium* in duck embryos. (15 min.) (Standard lantern). **R. B. McGhee,** University of Georgia.

WEDNESDAY EVENING, OCTOBER 30, 7:00 P.M.
LAFAYETTE ROOM, BENJAMIN FRANKLIN HOTEL

DINNER AND COUNCIL MEETING, OFFICERS AND MEMBERS OF THE SOCIETY'S COUNCIL.

(All past Presidents of the Society are cordially invited to attend both the dinner and the meeting.)

Thursday Morning Session A, October 31, 9:00 A.M.
Betsy Ross Room, Benjamin Franklin Hotel

A. O. Foster, USDA, PRESIDING

Read

23. A comparison of the effect of Aureomycin in combination with three levels of sulfamethazine in feed for the control of cecal coccidiosis of chickens. (10 min.) (Standard lantern). **J. L. Gardiner,** ARS, USDA.

24. The effect of Furazolidone administered in the feed upon coccidiosis (*Eimeria necatrix*). (15 min.) (2×2 lantern). **R. W. Wolfgang, D. I. Stunz,** and **P. D. Harwood,** Hess and Clark, Inc.

25. Furazolidone in the treatment of coccidiosis. (15 min.) (2×2 lantern). **P. D. Harwood, D. I. Stunz,** and **R. W. Wolfgang,** Hess and Clark, Inc.

26. The role of absorption in the activity of anticoccidial agents against *Eimeria tenella.* (15 min.) (Standard lantern, 2×2 lantern). **E. Waletzky** and **R. Probst,** American Cyanamid Company.

27. Effects of standard anthelmintics on experimental infections with *Nematospiroides dubius* Baylis in laboratory mice. (15 min.) (Standard lantern, 2×2 lantern). **R. Hewitt** and **A. Gumble,** American Cyanamid Company.

28. Anthelmintic effect of "Hygromix" (*S. hygroscopicus* fermentation products, Lilly) on helminths in swine. (10 min.) (2×2 lantern). **M. C. McCowen, F. O. Gossett, M. E. Callender,** and **M. C. Brandt,** The Lilly Research Laboratories.

29. Results of feeding small amounts of phenothiazine to calves with pure infections of *Cooperia punctata.* (15 min.) (2×2 lantern). **R. L. Mayhew, G. Miller,** and **Betty Torbert,** Louisiana State University.

30. Critical tests on the efficacy of Dow ET-57 as an anthelmintic in cattle. (10 min.) (2×2 lantern). **H. Herlich** and **J. M. Johnson,** ADP, ARS, USDA.

31. Chemoprophylactic action of piperazine dihydrochloride against a typhlitis in chicks. (10 min.) (Standard lantern). **I. W. Larsen** and **M. F. Hansen,** Kansas State College.

32. The control of the swine kidneyworm (*Stephanurus dentatus*) through management. (10 min.) (Standard lantern). **T. B. Stewart,** ARS, USDA.

33. The relation of a two-day pasture rotation system to the acquisition of gastrointestinal nematodes by sheep. (15 min.). **R. E. Bradley** and **N. D. Levine,** College of Veterinary Medicine and Agricultural Experiment Station, University of Illinois.

34. Comparison of the DCF and McMaster egg-counting techniques as applied to nematode parasitism of sheep. (8 min.) (Standard lantern). **G. I. Wilson,** ARS, USDA.

35. Notes on *Ascaridia dissimilis.* (10 min.). **K. B. Kerr,** Dr. Salsbury's Laboratories.

Read by Title Only

36. The influence of duration of therapy and type of infection on the antioxyurid activity of established agents. **G. M. Fanelli, Jr.,** and **C. H. Willey,** New York University, and **J. E. Lynch,** Pfizer Therapeutic Institute.

37. Observations on the arrested development of cattle nematodes. **H. H. Vegors,** ARS, USDA.

38. Survival of *Ancylostoma caninum* and *Taenia pisiformis* in Thiry fistulae of dogs. **G. Garoian,** Southern Illinois University.

Thursday Morning Session B, October 31, 9:00 A.M.
Franklin Room, Benjamin Franklin Hotel

Donald V. Moore, Southwestern Medical School, University of Texas, PRESIDING

Read

39. Comparative studies on amino acid absorption by cestodes. (12 min.) **J. W. Daugherty** and **W. B. Foster,** Rice Institute.

40. Helminth amino acid metabolism. I. Comparative studies on *Raillietina cesticillus* and *Hymenolepis diminuta.* (10 min.) (2×2 and standard lanterns). **W. B. Foster** and **J. W. Daugherty,** Rice Institute.

41. Effect of high temperatures on development of cestode larvae of the genus *Hymenolepis.* (10 min.) (Standard lantern). **M. Voge** and **D. Heynemann,** University of California.

42. The excystment of tapeworm larvae. (15 min.) (Standard lantern). **A. H. Rothman,** Johns Hopkins University.

43. Investigations on the use of X-irradiation as a mechanism for facilitating the study of morphological variation in *Hymenolepis nana.* (15 min.) (4×5 and 2¼×2¼ lanterns). **E. L. Schiller,** Johns Hopkins University.

44. The differentiation of *Hymenolepis diminuta* and *H. citelli.* (10 min.) (Standard lantern). **C. P. Read, A. H. Rothman,** and **K. Phifer,** Johns Hopkins University.

45. Studies on the embryonic development of a proteocephalid tapeworm. (10 min.) (2×2 lantern). **R. E. Ogren,** Ursinus College.

46. The spermatogenesis of two nematotaeniid cestodes. (6 min.) (Standard lantern). **L. T. Douglas,** Emory and Henry College.

47. The fertilization, maturation, and early cleavage in *Baerietta desmognathi sp. nov.* (Nematotaeniidae). (9 min.) (Standard lantern). **L. T. Douglas,** Emory and Henry College.

48. The effects of concurrent infections with the spiny-headed worm, *Moniliformis dubius,* on the rat tapeworm, *Hymenolepis diminuta.* (15 min.) (Standard lantern). **J. C. Holmes,** Rice Institute.

Read by Title Only

49. A study of the distribution of acid and alkaline glycerophosphatase activity in the cestode *Hymenolepis nana.* **J. H. Gilford,** Gettysburg College.

50. Aldolase in the larval form of *Taenia crassiceps,* Rudolphi 1810. **K. Phifer,** Johns Hopkins University.

Thursday Afternoon Session, October 31, 2:00 P.M.
Ballroom, Benjamin Franklin Hotel

Joint Meeting of the American Society of Tropical Medicine and Hygiene and the American Society of Parasitologists.

SYMPOSIUM: ZOONOSES IN THE TROPICS.
W. H. Wright, National Institutes of Health, PRESIDING

Some zoonoses which constitute important health problems in the tropics. **James H. Steele,** Veterinary Public Health, CDC, Atlanta, Georgia.

Human and animal trypanosomiasis in Africa. **D. G. Davey,** Imperial Chemical Industries, Ltd., Cheshire, England.

Tropical bat rabies as a public health and veterinary problem. **Eurelio Malaga-Alba,** Pan American Sanitary Bureau, Mexico, D.F., Mexico.

Tropical arthropod-borne viruses—their importance in veterinary and human medicine. **Morris Pollard,** University of Texas Medical School.

THURSDAY EVENING, OCTOBER 31, 8:00 P.M.
ROOM 206, BENJAMIN FRANKLIN HOTEL

MEETING OF THE EDITORIAL COMMITTEE AND BOARD, A.S.P.

(All past Committee members are cordially invited to attend.)

Friday Morning Session, November 1, 9:00 A.M.
Auditorium, Jefferson Medical College

Allen McIntosh, USDA, PRESIDING

Read

51. Enhancement of the *in vivo* schistosomacidal activity of antimony compounds by glycerol. (15 min.) (2×2 lantern). **G. W. Luttermoser,** National Institutes of Health.

52. Experimental *Schistosoma mansoni* infections in rhesus monkeys with particular reference to chemotherapy. (15 min.) (2×2 lantern). **H. H. Najarian, D. McCarthy, B. Olszewski, A. Bayles,** and **P. E. Thompson,** Parke, Davis and Company.

53. Studies of schistosomiasis mansoni in primates. (1) Initial occurrence of serologic antibodies correlated with egg recovery. (15 min.) (Standard lantern). **D. H. Naimark, J. Oliver-Gonzales, E. F. Chaffee,** and **R. I. Anderson,** U. S. Army Tropical Research Medical Laboratory and University of Puerto Rico.

54. A perfusion procedure (Perf-O-Suction) for recovery of schistosome worms. (10 min.) (Standard lantern). **M. G. Radke, L. A. Berrios-Duran,** and **K. Moran,** U. S. Army Tropical Res. Med. Lab., San Juan, Puerto Rico.

55. Further Studies on the size and shape of the eggs of the geographical strains of *Schistosoma japonicum*. (15 min.) (2×2 lantern). **H. F. Hsü** and **S. Y. Hsü**, State University of Iowa.

56. Alterations in serum glutamic-oxaloacetic transaminase (SGO-T) in the course of experimental schistosomiasis mansoni. (8 min.) (Standard lantern). **S. Garson, A. Duran,** and **J. S. Williams,** U.S. Army Tropical Research Medical Laboratory, San Juan, Puerto Rico.

57. Transamination in *Schistosoma mansoni*. (7 min.) (Standard lantern). **S. Garson** and **J. S. Williams,** U.S. Army Tropical Research Medical Laboratory.

Read by Title Only

58. Intradermal tests and their usefulness in the field for the detection of schistosomiasis japonica, paragonimiasis and clonorchiasis. **G. W. Hunter, III, L. S. Ritchie, C. Pan, S. Lin, S. Sugiura, K. Nagano,** and **M. Yokogawa,** 406th Medical General Laboratory, Tokyo; Yamanashi Medical Research Institute, Kofu; Kitasato Institute, Tokyo; Japanese Institute of Public Health, Tokyo.

59. The ecology of marine dermatitis-producing schistosomes. III. Oxygen consumption of normal and parasitized *Nassarius obsoletus* (*Nassa obsoleta*) under varying conditions of salinity. **C. Sindermann** and **A. Rosenfield,** Fisheries Research Station, Boothbay Harbor, Maine.

PRESIDENTIAL ADDRESS, AMERICAN SOCIETY OF PARASITOLOGISTS
11:15 A.M.

A. O. Foster, USDA, PRESIDING

60. Some reflections on the ecology of parasitism. **G. F. Otto,** Abbott Laboratories.

Friday Noon, November 1, 12:15 P.M.
Ballroom, Benjamin Franklin Hotel

Annual Luncheon and Business Meeting of the Society.
Gilbert F. Otto, PRESIDING

(Get tickets at time of registration)

Friday Afternoon Session, November 1, 2:30 P.M.
John Houston Lounge, Houston Hall, University of Pennsylvania

George L. Graham, IN CHARGE

(Laboratories will be open all Friday morning for setting up demonstrations.)

All Papers by Demonstration and Exhibit

61. Technical procedures for tissue culture propagation and phase contrast photomicrographic studies of exoerythrocytic stages of *Plasmodium gallinaceum* and *P. fallax*. **A. C. Pipkin, C. G. Huff,** and **D. V. Jensen,** Naval Medical Research Institute.

62. A fourth species of *Neoechinorhynchus* (Acanthocephala) in turtles of the United States. **R. M. Cable** and **F. M. Fisher, Jr.,** Purdue University.

63. Ultra-structure of *Rhabditis strongyloides*. **C. R. Peebles,** University of Illinois. (See Abstract #120)

64. Filarial parasites of the rice rat. **J. A. Scott, E. M. MacDonald,** and **J. H. Cross, Jr.,** The University of Texas Medical Branch.

65. Nematodes in Grand Canyon rodents: *Syphacia, Gongylonema,* and *Rictularia*. **F. J. Kruidenier** and **C. R. Peebles,** University of Illinois.

66. *Platynosomum fastosum* in an Illinois Cat. **N. D. Levine** and **P. D. Beamer,** University of Illinois.

67. A progenetic lecithodendriid trematode from a calopterygid damselfly naiad. **J. E. Hall,** Purdue University.

68. Studies on the biological control of schistosome-bearing snails: The general histology and topographic microanatomy of *Australorbis glabratus.* **C. Pan,** Harvard School of Public Health. (Introduced by **Thomas H. Weller.**)

69. Schistosomiasis in Japan. **K. Okabe,** Kurume University. (A 30-minute movie in color; showings at **2:30 p.m.** and **3:00 p.m.,** Franklin Room, Houston Hall, University of Pennsylvania.)

70. Studies on the cercariae of the Mountain Lake Region. **F. J. Etges,** University of Cincinnati.

71. Further uses of a planetary-type mixing machine adapted for separating worm eggs from feces. **C. H. Hill** and **R. E. Zimmerman,** ARS, USDA.

72. A field thermistor thermometer for microhabitat temperature studies. **C. W. McNeil** and **W. M. Walter,** State College of Washington.

73. Sex determination and oviposition rate in the snake mite *Ophionyssus natricis* (Gervais) (Mesostigmata: Dermanyssidae). **J. H. Camin** and **P. R. Ehrlich,** The Chicago Academy of Sciences.

Saturday Morning Session A, November 2, 9:00 A.M.
Betsy Ross Room, Benjamin Franklin Hotel

Raymond M. Cable, Purdue University, PRESIDING

Read

74. *Trichobilharzia alaskensis,* a new avian schistosome from Alaska. (15 min.) (2×2 lantern). **R. Harkema, S. McKeever,** and **D. A. Becker,** North Carolina State College, University of California at Davis, and the University of Nebraska.

75. Larval trematodes of the Columbia Basin, Washington. (10 min.) (2×2 lantern). **A. Deforest** (introduced by **C. W. McNeil**).

76. Some trematodes from Sapelo Island and adjacent mainland. (12 min.) (Standard lantern). **E. E. Byrd, M. C. Dunn,** and **H. E. Jordan,** University of Georgia.

77. Notes on *Spirorchis haematobium* (Stunkard, 1922) in the definitive host. (Trematoda: *Spirorchiidae*). (5 min.) (2×2 lantern). **M. J. Ulmer,** Iowa State College.

78. The homologies of the clamp sclerites of *Hexostoma,* (Hexostomatidae: Diclidophoroidea). (10 min.) (2×2 and standard lanterns). **W. J. Hargis, Jr.,** The Virginia Fisheries Laboratory.

79. Some observations on the life cycle of *Strigea elegans,* Chandler and Rausch, 1947 (Trematoda: Strigeidae). (15 min.) **J. C. Pearson,** University of Queensland (Introduced and read by **R. S. Freeman**).

80. The histopathology of the tumor on the brain of the Stickleback caused by *Diplostomum baeri eucaliae* Hoffman and Hundley, 1957. (10 min.) (2×2 lantern). **G. L. Hoffman** and **J. B. Hoyme,** University of North Dakota.

81. Preliminary observations on the oviposition and hatching of eggs of aedine mosquitoes. (10 min.) (2×2 lantern). **A. R. Barr,** University of Kansas.

82. Some aspects of the biology of *Cuterebra angustifrons* Dalmat, 1942 (Cuterebridae: Diptera). (15 min.) (2×2 lantern). **E. I. Sillman,** Ontario Agricultural College.

83. Host-parasite relations of the screw-worm. (10 min.) **J. H. Esslinger,** Rice Institute.

84. Feeding behavior of the snake mite, *Ophionyssus natricis* (Gervais) and other dermanyssidae (Acarina: Mesostigmata). (10 min.) (2×2 lantern). **J. H. Camin** and **P. R. Ehrlich,** The Chicago Academy of Sciences.

85. Observations on the acarine family *Speleognathidae* including two previously unreported forms in native game birds. (10 min.) (2×2 lantern). **G. M. Clark,** U.S. Fish and Wildlife Service, Patuxent Research Refuge.

86. Food habits of laelaptid mites in relation to pathogen vector potentials. (10 min.) (2×2 lantern). **D. P. Furman,** University of California, Berkeley, California.

87. Observations on *Micromegistus bakeri* Trägårdh, 1948, an antennophoroid mite occurring on scarites bettles. (15 min.) (2×2 lantern). **D. E. Johnston, G. E. Johnston,** and **D. L. DeGuisti,** Wayne State University.

Read by Title Only

88. The cercarial type in the genus *Allocreadium.* **L. E. Peters,** Purdue University and University of Michigan Biology Station.

89. Comparative morphology of miracidia in the Gorgoderidae. **D. Wootton** and **L. Peters,** University of Michigan Biological Station, Woods Hole Marine Biological Laboratory, and Purdue University.

90. Brown and white pelicans as hosts for schistosomes of the genus. *Gigantobilharzia.* **W. H. Leigh,** The University of Miami.

91. The life-history of a new trematode of the genus *Paramacroderoides* in the Florida spotted gar. **W. H. Leigh,** The University of Miami.

92. Digenetic trematodes in Louisiana fresh-water fishes. **G. C. Miller** and **H. J. Bennett,** Louisiana State University.

93. Dicyemid mesozoans from the Gulf of Mexico. **R. B. Short,** Florida State University.

94. The concept of vector efficiency in experimental studies of plague. **L. Kartman,** CDCA, San Francisco Field Station.

95. Studies on the biology of the lone star tick, *Amblyomma americanum* (L.), at Camp Bullis, Texas. **G. W. Hunter, III, J. V. Griffo, J. W. Williams,** and **F. M. Philips,** University of Florida and the Fourth Army Area Medical Laboratory, Ft. Sam Houston, Texas.

Saturday Morning, Session B, November 2, 9:00 A.M.
Franklin Room, Benjamin Franklin Hotel

William Trager, Rockefeller Institute for Medical Research, PRESIDING

Read

96. Investigations on the cultivation of *Toxoplasma gondii* in tissue cultures. (10 min.) (Standard lantern). **M. K. Cook** and **L. Jacobs,** National Institutes of Health, Bethesda, Maryland.

97. Staining of *Toxoplasma gondii* in frozen sections using fluorescein-labelled antibody. (10 min.) (2×2 lantern). **R. K. Carver** and **M. Goldman** (with technical assistance of **J. Huey**), Communicable Disease Center.

98. Immunity to toxoplasmosis in the newborn rat. (10 min.) (Standard lantern). **E. K. Markell** and **W. P. Lewis,** University of California, School of Medicine.

99. Studies on the resistance of pseudocysts of *Toxoplasma gondii.* (8 min.) (Standard lantern). **L. Jacobs** and **M. L. Melton,** National Institutes of Health, Bethesda, Maryland.

100. A procedure for testing meat samples for *Toxoplasma,* with preliminary results of a survey of pork and beef samples. (7 min.) (Standard lantern). **L. Jacobs** and **M. L. Melton,** National Institutes of Health, Bethesda, Maryland.

101. Changes in virulence to laboratory mice of newly isolated strains of *Toxoplasma gondii.* (10 min.) **D. E. Eyles, N. Coleman,** and **C. L. Gibson,** National Institutes of Health, Memphis, Tennessee.

102. Cultivation of *Trichomonas vaginalis,* Donne, 1837, in association with tissue cultures. (15 min.) **E. Kotcher** and **A. C. Hoogasian,** University of Louisville, School of Medicine.

103. Studies on the physiology of *Trichomonas hominis.* (15 min.) **J. M. Solomon,** The Johns Hopkins University.

104. Comparative pathogenicity of several strains of *Trichomonas gallinae* and *Trichomonas vaginalis* to mice. (10 min.) (Standard lantern). **B. M. Honigberg,** University of Massachusetts.

105. Further observations on the passage of virulent *Trichomonas gallinae* through successive non-immune domestic pigeons. (12 min.) (Standard lantern). **R. M. Stabler,** Colorado College.

106. Intestinal parasite surveys on Indian reservations in Montana, South Dakota, New Mexico, Arizona, and Wisconsin. (10 min.) (2×2 lantern). **M. M. Brooke** and **D. M. Melvin,** Communicable Disease Center, Atlanta, Georgia.

107. The effect of changes in pH and specific gravity on the recovery of certain helminth eggs and protozoan cysts in the formalin-ether (406th MGL) fecal concentration technique. (5 min.) (Standard lantern). **M. M. Winn, A. P. Moon, S. S. Lin, S. Asakura,** and **H. Yoshida** (introduced by **D. B. McMullen**), 406th Medical General Laboratory, San Francisco, California.

108. On the relation of the biology of *Entamoeba invadens* to its pathogenicity in snakes. (15 min.) (2×2 and standard lanterns.) **E. Meerovitch,** Macdonald College of McGill University.

109. Gregarines in marine crustacea taken at Bombay, India. (10 min.) (2×2 lantern). **G. H. Ball,** University of California at Los Angeles.

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110. The distribution of *Toxoplasma gondii* in the muscles of rats with chronic infections. **L. Jacobs** and **M. L. Melton,** National Institutes of Health, Bethesda, Maryland.

111. Certain B Complex vitamins as growth-promoting factors for *Trichomonas gallinae*. **I. Jones** and **B. F. Smith,** Spelman College.

112. The effect of lysozyme-killed bacteria on the growth of *Entamoeba histolytica*. **M. Nakamura,** Montana State University.

113. Myxosporidiosis in immature sea herring from the Gulf of Maine. **C. J. Sindermann,** U. S. Fish and Wildlife Service, Boothbay Harbor, Maine.

114. Studies on the pathogenicity of *Ichthyosporidium hoferi*, fungus parasite of fishes. **C. J. Sindermann,** U. S. Fish and Wildlife Service, Boothbay Harbor, Maine.

Saturday Afternoon Session, November 2, 2:00 P.M.
Betsy Ross Room, Benjamin Franklin Hotel

Gilbert F. Otto, Abbott Laboratories, PRESIDING

Read

115. Immune precipitates on nematode larvae studied *in vitro* with fluorescent and unlabeled serums. (15 min.) (2×2 and standard lanterns). **G. J. Jackson** and **R. M. Lewert,** The University of Chicago.

116. Serum agar double diffusion studies with *Ascaris* antigens. 2. Analysis of polysaccharide antigens. (15 min.) **I. G. Kagan*** and **E. L. Jeska,** The University of Pennsylvania. (* Present address—CDC, Chamblee, Georgia.)

117. Hemagglutination studies with *Ascaris* antigens. (10 min.) **I. G. Kagan***, The University of Pennsylvania.

118. Differences in susceptibility of rice rats and cotton rats to various strains of filarial worms. (8 min.) (Standard lantern). **J. A. Scott, E. M. Macdonald** and **J. H. Cross, Jr.,** The University of Texas, Medical Branch.

119. Glycolysis in *Trichinella spiralis* larvae. (10 min.) (Standard lantern). **E. Goldberg** (introduced by **L. O. Nolf**), State University of Iowa.

120. Ultra-structure of *Rhabditis strongyloides*. (15 min.) (Standard lantern). **C. R. Peebles,** University of Illinois.

121. *Ascaris laevis* migration in experimental hosts. (15 min.) (2×2 lantern). **B. B. Babero,** The University of Illinois.

122. The development of *Toxocara canis* (Werner, 1782) in the dog. (15 min.) (2×2 lantern). **J. F. A. Sprent,** University of Queensland, Brisbane, Australia.

123. The axenic cultivation of *Strongyloides ratti* and *Strongyloides sp.* from the rhesus monkey. (15 min.) (2×2 and standard lanterns). **P. P. Weinstein** and **M. F. Jones,** National Institutes of Health, Bethesda, Maryland.

124. The axenic cultivation of *Nematospiroides dubius*. (15 min.) (2×2 and standard lanterns). **M. F. Jones** and **P. P. Weinstein,** National Institutes of Health, Bethesda, Maryland.

Read by Title Only

125. Paper chromatography of *Nippostrongylus muris larvae*. **F. Friedman** and **I. G. Kagan***, The University of Pennsylvania.

126. Unidentified factors required by *Caenorhabditis briggsae* (Nematoda). I. Factors Rb and Cb. **E. C. Dougherty** and **E. L. Hansen,** University of California (Berkeley).

127. Unidentified factors required by *Caenorhabditis briggsae* (Nematoda). II. An assay system for factor Cb. **E. C. Dougherty** and **E. L. Hansen,** University of California (Berkeley).

128. Infection with *Enterobius* in Egypt. **J. A. Scott,** The University of Texas, Medical Branch, at Galveston.

129. Life history studies on *Porrocaecum ensicaudatum*, an avian nematode. **N. L. Levin,** University of Illinois.

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ABSTRACTS

1. **Notes on Further Studies of the Inheritance of Resistance to Trichostrongylidosis in Sheep.** J. H. WHITLOCK AND HOLGER MADSEN, New York State Veterinary College, Cornell University.

In earlier papers we reported the existence of a factor for inherited resistance to trichostrongylidosis in sheep. This was named the violet factor after the ram in which it was first recognized. Further experimentation has not given any evidence that the violet factor is anything more than a simple dominant genetic factor. No increase of resistance was noted in inbred violet progeny nor in violet progeny from ewes with a prior history of producing resistant offspring. All other rams upon which we have sufficient data were apparently heterozygous for the factor. The phenotypic expression of the violet factor under challenge with the disease is subject to a considerable variation. Diet, pregnancy and probably other genetic factors influence its expression and its duration. Definitive proof of the genetic mechanism of the violet factor is to be most easily found in the establishment of a breeding flock of susceptible individuals homozygous to the recessive allele of the violet factor. This has been sufficiently difficult that we suspect that the homozygous recessive condition may operate as a semi-lethal.

2. **Preliminary Studies on Trichostrongylids in Sheep by Means of a Gastric Pouch.** HOLGER MADSEN AND JOHN H. WHITLOCK, New York State Veterinary College.

Successful abomasal pouches were established in a total of 6 sheep, 2 from genetically susceptible and 4 from genetically resistant strains.

In preliminary trials adult female *Haemonchus* exposed to pouches for an hour survived longer in an incubator if the exposure was to a susceptible sheep.

Infecting the pouches with ensheathed or exsheathed larvae resulted in a higher survival rate in the susceptible sheep.

Thus far the technic has indicated that the expression of resistance is variable. Variation in pouch resistance has been confirmed by variation in resistance of these sheep to repeated infections by the normal routes.

3. **Studies on the Effect of X-rays on the Infective Stage of the Nematode** *Trichostrongylus axei.* H. CIORDIA, Regional Animal Disease Research Laboratory Substation, Agricultural Research Service, USDA, Experiment, Georgia.

Studies on the effect of X-rays on the infective stage of the nematode *Trichostrongylus axei* are in progress. In the first experiment 15 rabbits were divided into 5 groups of 3 rabbits, each of which was fed 4,000 infective larvae. The first 4 groups received larvae previously exposed to 1,000, 2,000, 5,000, and 10,000 roentgen units, respectively. The fifth group received non-irradiated larvae. More worms were recovered from rabbits infected with larvae treated with 5,000r than from rabbits in the other groups. Besides this apparent increase in the infectivity of the larvae, the number of eggs passed per adult worm recovered was also increased by that level of radiation, although the percentage of larval development, as determined by fecal cultures, was not affected.

The experiment was repeated, again utilizing 15 rabbits. This time the 1,000r treatment was replaced by a 20,000r treatment. The increase in infectivity of the larvae exposed to 5,000r was again apparent. No larvae reached maturity following irradiation of 20,000r. A dose of 10,000r did not have any apparent effect on the larvae.

4. **The Effect of Green Feed Upon the Development of** *Trichostrongylus axei* **in the Laboratory Rabbit.** G. H. ROHRBACHER, JR., Regional Animal Disease Research Laboratory, Agricultural Research Service, USDA, Auburn, Alabama.

During feeding experiments conducted with grade California white rabbits experimentally infected with *Trichostrongylus axei* (bovine strain), it became apparent that fresh green feed (Johnson grass alone, kudzu alone, and alfalfa fed as a supplement to a commercial diet) inhibited development of this nematode more than did a standard, commercial pelleted rabbit feed.

When data were pooled from the experiments on 16 animals fed green feed, it was found that 68% of the nematodes recovered after 30 days' infection were immature. Only 29% immature *T. axei* were recovered from 16 rabbits fed the commercial pellets. The difference between the means was significant at the 0.01 level. There was no significant difference between the total number of worms recovered, and the sex of the host had no apparent effect upon the number of nematodes.

When the effect of a fresh alfalfa supplement on pregnant females was tested, no significant

difference was found in the percentage of immature worms between those animals receiving alfalfa and those on the commercial diet only, nor was there any difference between pregnant rabbits fed alfalfa and all other animals maintained on the commercial diet. However, there was a significant difference in the percentage of immature *T. axei* recovered from pregnant and nonpregnant rabbits fed green feed.

Experiments are now being conducted to determine if the difference may be due to the lack of ascorbic acid in the commercial feed.

5. **The Experimental Infection of Swine with Nematodes of Ruminants.** F. G. TROMBA AND F. W. DOUVRES. Animal Disease and Parasite Research Division, Agricultural Research Service, USDA, Beltsville, Maryland.

A 5-week-old pig, to which 1,200,000 infective larvae from a bovine source, including the species *Ostertagia ostertagi, Trichostrongylus colubriformis, Cooperia* spp., and *Dictyocaulus viviparus,* were administered, died 6 days later from an intercurrent pericarditis and endocarditis aggravated by the large number of developing larvae. At necropsy the mucosa of the stomach and of the small intestine was found to be eroded and friable, with hemorrhagic areas. From mucosal scrapings and stomach contents 22,400 *O. ostertagi* were recovered, of which 16,800 were fourth-stage, the remainder being parasitic third-stage. Of 420 *T. colubriformis* recovered from the small intestine, 150 were fourth-stage and the rest parasitic third-stage.

Subsequently, to 3 littermates of the initially infected animal, 1,200,000 of the aforementioned mixture, 130,000 *O. ostertagi,* and 23,000 *Trichostrongylus axei* with 25,000 *Cooperia* spp. were administered, respectively. These pigs were sacrificed 21, 26, and 26 days, respectively, after infection. Eight hundred and twenty-four sexually mature *T. colubriformis* and 192 *O. ostertagi,* of which 188 were parasitic third-stage and 4 were fourth-stage, were recovered from pig 1; 10 fourth-stage *O. ostertagi* from pig 2; and 320 sexually mature *T. axei* from pig 3.

Internal organs of the 3 animals were grossly normal except the gastrointestinal tracts, which were inflamed, particularly the stomach of pig 3. These results indicate that *T. colubriformis* and *T. axei* can mature in normal young pigs, but that little or no development of *O. ostertagi* occurs unless the animal is in a weakened condition. *D. viviparus* and *Cooperia* spp. did not develop in the weak or healthy pigs. Application of these findings to field conditions and animal husbandry practices will be discussed.

6. **The Effect of the Nematode, *Trichostrongylus axei,* (Cobbold, 1879) on the Utilization and Excretion of Certain Elements.** R. F. SHUMARD, North Dakota Agricultural Experiment Station.

Twenty-four-hour consumptions and excretions (via urine and feces) of sodium, potassium, calcium, phosphorus, and protein nitrogen of non-infected lambs and lambs infected with *Trichostrongylus axei* were tabulated for 26 days. Results indicate that the infected animals maintained a relatively high sodium level while excretion of potassium, calcium, phosphorus, and protein nitrogen approached and in some cases exceeded consumption levels.

7. **Further Studies on Ovine Strongyloidiasis: An Attempt to Induce Passive Immunity.** J. H. TURNER, Animal Disease and Parasite Research Division, Agricultural Research Service, USDA, Beltsville, Maryland.

The writer (1956, J. Parasitol. **42** (Suppl.): 18–19) reported that lambs and kids rapidly developed resistance to infection with *Strongyloides papillosus* after exposure for several weeks to small immunizing doses of infective larvae. Immunological study of this parasite in lambs has been continued, particularly in respect to transfer of resistance to infection passively by injections of immune serum. Incidental observations were also made on the reaction of infective larvae incubated in immune serum, and on changes in serum proteins after infection.

"Immune" serum was injected intravenously into 4 parasite-free lambs in quantities of 5, 2.5, 0.5, and 0.1 ml, respectively, per pound of body weight. One control lamb received 5 ml of normal serum and another 5 ml of physiological saline per pound of body weight. Immediately thereafter all lambs were infected percutaneously with 150,000 infective larvae. During the post-infection period of 8 weeks no significant differences were noted between the "immunized" and control lambs; in fact, at autopsy more parasites were recovered from the "immunized" than from the control lambs.

When infective larvae were incubated at 37° C in "immune" serum, oral and anal precipitates formed in about 4 hours. Serum protein changes that occurred after infection of these lambs, as determined by paper electrophoresis, were (a) a rapid decline in the A/G ratio

during the first 3 weeks, (b) a corresponding increase in gamma globulin 2 weeks after infection, and (c) a marked increase in beta globulin a week later. It appears, therefore, that infections of *S. papillosus* in lambs may produce more than one antibody.

8. **Parasitism, Parthenogenesis and Polyploidy: the Life Cycle of** *Strongyloides papillosus.* PATRICIA C. H. CHANG AND GEORGE L. GRAHAM, Dept. of Parasitology, School of Veterinary Medicine, University of Pennsylvania.

Cytological observations on Feulgen-stained specimens of the parasitic or homogenetic phase of *Strongyloides papillosus,* obtained from experimentally infected rabbits, have revealed constant chromosomal differences when compared with similarly prepared material of the free-living bisexual, or heterogenetic, phase of this nematode. No evidence of sperm has ever been found in the uteri of the unisexual, gynomorphic parasites. The normal chromosome number (six) is observable in some ripe eggs, prior to cleavage. Other eggs may show four chromosomes and a small, compact mass of Feulgen positive material which we designate as an "extrusion body". Two chromosomes are frequently shorter than the other pair. Occasionally eggs contained two "extrusion bodies". We have not yet determined the chromosome number of such eggs.

In the heterogenetic generation, eggs never develop in the absence of "fertilization". In virgin females, the large, vesicular egg nucleus contains two tetrad chromosomes differing in size, which rest against the nuclear membrane opposite each other. In spermatized females, eggs occur with the tetrads side by side during polocyte production following sperm entry. The *single* maturation division is equational; there is no meiosis. The resultant diploid, female pronuclei have four chromosomes, two being smaller. Fusion with haploid, male pronuclei produces viable, triploid zygotes, destined to develop into infective filariform larvae and capable of further development into parthenogenetic, parasitic females. Though morphologically and biologically different from their mother, the basic distinction resides in an extra "set" of chromosomes. In the triploid, parthenogenetic parasite, the determinant factor—and this may be genetic—for homogenetic or heterogenetic development lies between normal mitoses during oocyte growth and one or more abnormal cell divisions which may involve non-disjunction, yet simulates polocyte production.

9. **Preliminary Observations on the Life History of the Sheep Pinworm,** *Skrjabinema ovis.* G. A. SCHAD, Animal Disease and Parasite Research Division, Agricultural Research Service, USDA, State College, New Mexico.

Skrjabinema ovis is a cosmopolitan nematode parasite of wild and domestic sheep and goats, but little is known of its pathogenesis and life cycle.

Eggs for experimental infections were obtained from female pinworms collected from domestic sheep and goats. Fully matured females were removed directly from the rectum of infected hosts and allowed to deposit their eggs in tap water. These eggs were fully embryonated on deposition, and no morphological development was observed with incubation in water at room temperature. Eggs were not usually found in feces, but were collected by the "Scotch tape" method from the perianal skin, where they were deposited normally. Some data showed that in goats the mature females migrated to this region during the night, but this was not confirmed in sheep.

The infective larva within the egg is probably in the third stage. *In vitro* studies indicated that hatching occurred in the small intestine, because successive passages through gastric and intestinal fluids were necessary for hatching.

Only fourth stage larvae were recovered on the 12th and 17th days after infection. The smallest of these larvae at 12 days measured 300 microns in length. At 17 days, fourth stage larvae ranged up to 1,400 microns long at the time of the molt just preceding the adult stage. By the 25th day, almost all of the larvae were adults. The larval stages were not characterized by marked morphological changes.

10. **Preliminary Experiments on Transmission of Gastrointestinal Nematodes of Ovine and Caprine Origin to Lambs and Kids on Pasture.** G. I. WILSON AND K. C. KATES, Animal Disease and Parasite Research Division, Agricultural Research Service, USDA, Beltsville, Maryland.

Domestic sheep (*Ovis aries*) and goats (*Capra hircus*) are commonly parasitized by the same species of gastrointestinal nematodes. However, little is known of possible differences in susceptibility of these hosts to nematode infection. The following experiments were carried out to obtain some preliminary data on possible variations in acquisition by lambs and kids of

nematodes of both ovine and caprine origin. One ¼-acre pasture was contaminated by grazing parasitized sheep thereon for 2 weeks, another by grazing parasitized goats. After resting the pastures for 2 weeks, 2 parasite-free lambs and 2 parasite-free kids were grazed on each pasture for 1 week. The test animals were removed to pens for 3 weeks and then autopsied, and the nematodes were recovered, identified, and counted. This experiment was repeated the succeeding year. Thus, 8 test lambs and 8 test kids were examined, or 4 of each from both ovine and caprine contaminated pastures. The number of *Haemonchus contortus* recovered from the test animals were variable and no trends were noted; the total number from the 8 test lambs was about equal to that from the 8 test kids. However, more worms of the following species were recovered from the test kids than from the test lambs, regardless of the host origin of the parasites: *Ostertagia circumcincta, Trichostrongylus colubriformis, Cooperia curticei, Nematodirus spathiger, Oesophagostomum venulosum,* and *O. columbianum* (nodules and young worms). Some data suggested that the test lambs acquired proportionately more worms of caprine than of ovine origin, and the test kids more worms of ovine than of caprine origin.

11. **Observations on the Relation of Serum Protein Changes, Antibody Formation, and Eosinophilia in Cattle Infected with the Lungworm,** *Dictyocaulus viviparus.* THOMAS B. WEBER, Animal Disease and Parasite Research Division, Agricultural Research Service, USDA, Beltsville, Maryland.

Changes occurring in the serum proteins of cattle exposed and re-exposed to the lungworm, *Dictyocaulus viviparus,* were investigated in an attempt to correlate the increase in gamma globulin with antibody formation and eosinophilia. Electrophorograms showed that gamma globulin increased beginning about 1 week after infection, attained a maximum 4 weeks later, persisted for different periods according to the number of exposures, and then gradually returned to normal.

The complement-fixing antibody response was first detected slightly less than 2 weeks after infection, reached a peak a few days later, and persisted for about 2 months. Lower antibody titers were maintained several months longer. The formation of precipitates about the openings of mature worms immersed in serum from infected calves first occurred in samples collected about 2 weeks after infection, reached a maximum about the 4th postexposure week, and remained at this level for several months.

An increase in the percentage of eosinophiles was first detected about 1 week after exposure, attained a peak about 1 week later, declined during the next 1 to 2 weeks, and then rose to a lower secondary peak, which persisted for 3 to 9 weeks.

Although no direct quantitative relation between gamma globulin, antibody titers, and eosinophilia was demonstrated, increases in gamma globulin and percentage of eosinophiles appeared to be associated with antibody-formation and titer in the serum of cattle infected with lungworms.

12. **Problems of Nematode Control in the Captive Giraffe and Okapi.** B. J. JASKOSKI, Loyola University (Chicago), and The Chicago Zoological Park.

Problems of nematode control in captive animals are aggravated by 1) the introduction of parasites from the native habitat into the captive habitat; 2) the augmentation of reinfection pathways in confined areas; and 3) infections from parasites already present in the captive environment. Complete elimination of nematode parasites from giraffes and okapis in captivity appears unlikely at present because of the factors mentioned and the lack of an ideal anthelmintic. An approach to the problems is presented in this discussion. Certain remedial measures were instituted in efforts materially to reduce the nematode burdens in these animals. Weekly analyses of fecal samples are made from the stools of 2 okapis and 4 giraffes which constitute the current colonies. Nematode egg numbers have been significantly reduced because of the remedial measures and addition of mineral-vitamin supplement to the diets. Some aspects of variation in numbers of eggs seen on different examinations are discussed.

13. **Host Specificity of** *Nippostrongylus,* A. JAMES HALEY, University of Maryland.

The host specificity of *Nippostrongylus muris* was studied by comparing the development of the parasite in a normal host, the laboratory rat, and an abnormal host, the hamster. Rats harbored, on the average, about 14 times as many adult worms as hamsters, 9 to 10 days after inoculation of the two hosts with similar doses of a rat strain of the parasite. This difference could not be attributed to differences in the life history dynamics of the adult worm populations in the two hosts. Several hundred living third-stage larvae were recovered from the lungs of hamsters but not from the lungs of rats up to the 18th day of infection. It was clear that a

much greater proportion of larvae failed to complete the somatic migration in hamsters than in rats and this finding was regarded as sufficient to explain the magnitude of the difference between the adult worm burdens in the two hosts. Male hamsters harbored, on the average, nearly 25 times as many adult *N. muris* as females.

On 2 occasions it was demonstrated that *N. muris* of rat origin could be established and maintained independently in hamsters and that the passage of the parasite in hamsters increased its infectivity for this host. One of these hamster strains (HSI), which was passed 24 times through hamsters, developed about 7 times better in hamsters than the parent rat strain did in this host. Hamsters infected with rat strain exhibited a marked sex difference but in those given HSI the sex difference was greatly reduced or lacking.

14. **Isolation of *Trypanosoma cruzi*-like Organisms from Wild Animals Collected in Georgia.** MARION M. BROOKE, LOIS NORMAN, DOROTHY ALLAIN, AND G. W. GORMAN, Communicable Disease Center, Atlanta and Newton, Georgia.

Hemoflagellates have been isolated from a number of wild animals in South Georgia. Using *Trypanosoma rangeli* and the Corpus Christi strain of *Trypanosoma cruzi* for comparison, the hemoflagellates from a skunk, a raccoon, and several opossums have been studied in culture, in triatomid bugs, and in mouse blood and tissue. The isolates from the skunk and the opossum have *T. cruzi*-like characteristics. The one from the raccoon is also more like *T. cruzi* than *T. rangeli*, but appears somewhat different in culture from the other organisms.

15. **Respiration of *Trypanosoma cruzi* during *in vitro* Growth.** L. G. WARREN,* The Johns Hopkins University.

The respiratory rate of culture forms of *T. cruzi* increases with increasing age of culture. Production of ammonia during endogenous respiration, could not be detected using an HCl absorbent technique. Intracellular polysaccharide could not be detected in the organisms by staining with iodine. The role of lipids in endogenous respiration has not been explored. The respiratory rate in the presence of added glucose increases with the age of the culture. However, the percent stimulation of respiration over the endogenous rate remains quite constant throughout the age groups studied.

Respiration was found to be independent of parasite concentration in the range 0.4 to 3.1×10^8 organisms per ml.

Respiration was independent of glucose concentration in the range 2.8×10^{-4} to 7×10^{-3}M. However, the stimulation of respiration by a 1.4×10^{-4}M glucose concentration was greater than endogenous controls, but less than that produced by higher concentrations. The latter concentration was the lowest at which a stimulation could be detected.

The efficiency of glucose oxidation by culture forms of *T. cruzi* has been determined by manometric and chemical assay and the oxygen : glucose ratio was found to be 2.6 and 2.8 for the respective techniques. These results suggest that respiration in the presence of glucose does not displace endogenous respiration.

Galactose and mannose, as well as glucose, were found to stimulate the respiration of *T. cruzi*. Glycogen, sucrose, beta-hydroxy butyrate, acetate, glycine, alanine, glutamate, and aspartate did not stimulate the respiration of *T. cruzi*. (*USPHS Research Fellow of the National Institute of Allergy and Infectious Diseases.)

16. **Studies on the Properties of Anti-*Trypanosoma cruzi* Factors in Chicken Sera.** TIBOR BORSOS* AND LIONEL G. WARREN*. Johns Hopkins University.

Adult chicken serum lyses *Trypanosoma cruzi*. The reaction appears to involve heat-stable and heat-labile factors. The heat-stable (at 56° C—25 minutes), or agglutinating factor, has the following properties: a) agglutinates live trypanosomes in the temperature range 0 to 37° C, and at dilutions to 1 : 1000; b) is unaffected by 10^{-2}M ethylene diamine tetraacetate (EDTA); c) the agglutinating factor is not trypanocidal. The heat-labile factor has the following properties: a) heating at 56° C for 25 minutes destroys the lytic activity; b) 1 : 100 dilution abolishes lytic activity; c) 10^{-2}M EDTA prevents lysis; added Ca^{++} and Mg^{++} restores lytic activity; d) it is not absorbable with specific precipitate (bovine serum albumin—rabbit anti-bovine serum albumin).

The epigenesis of chicken anti-*T. cruzi* factors has been studied in chick embryos and young chickens. Eleven-day embryonic sera lack both lytic and agglutinating activity. Fifteen-day embryonic sera have slight agglutinating but no lytic activity. Eighteen-day embryonic sera lyse and agglutinate *T. cruzi*. Young chicks 5–9 days of age possess either lytic or lytic and agglutinating factors. At 4 weeks only the lytic effect could be observed.

The results of this study indicate that the agglutinating factor is transmitted to the embryo from the immune mother and is actively acquired in later life. Further evidence is presented for the complement-like nature of the heat-labile factor. The significance of the age distribution of these factors and their possible relation to host susceptibility will be discussed. (*USPHS Pre-doctoral Research Fellow.)

17. **Antigenic Relationships of Certain Hemoflagellates as Determined by the Ouchterlony Gel Diffusion Technique.** DONALD V. MOORE, The University of Texas Southwestern Medical School.

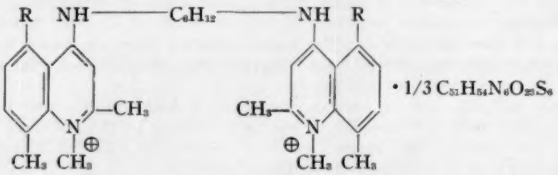
Sera from rabbits immunized with cultural forms of *Leishmania tropica* (Teheran strain), *L. donovani* (Khartoum strain) and 3 strains of *Trypanosoma cruzi* (including 2 strains isolated from cases in Texas) were tested against homologous and heterologous antigens for antigenic relationships.

18. **Some Considerations on the Nature of Immunity in *Trypanosoma lewisi* Infections.** ASA C. CHANDLER, Rice Institute, Houston, Texas.

The recent demonstration that rats can be immunized to *T. lewisi* infections by injection of metabolic products of the trypanosomes, and that the ablastin so produced is responsible not only for inhibition of reproduction but for the agglutination of the parasites as well, throws new light on some of the results obtained by earlier workers. In the present paper the significance and meaning of these demonstrations will be considered, and possible re-interpretations of some of the results of others will be attempted.

19. **The Prophylactic Action of a Sulfonate Salt of Quaternary *bis*-Quinaldines Against *Trypanosoma congolense* in White Mice.** G. F. OTTO, J. C. MOETSCH, AND R. U. SCHOCK, Abbott Laboratories.

At the 31st Annual Meeting of this Society, we presented evidence of marked therapeutic activity of certain quarternary *bis*-quinaldines against blood-induced *Trypanosoma congolense* infection in white mice (J. Parasitol. 1956, **42** (Suppl.): 21–22). Sulfonate salts of several of the more active compounds were prepared and found to have essentially the same therapeutic action as the inorganic salts of the same compounds. However, the sulfonate salts of these compounds were found to be effective prophylactic agents against the same infection. Several of them have protected against a primary infection attempted, so far, 1, 2, and 3 months after the administration of the drug. The compounds which will be discussed have the following structure:



20. **A Comparative Study of Experimental Leishmaniasis in the Mouse, Mongolian Gerbil, Hamster, White Rat, Cotton Rat and Chinchilla.** J. GRUN AND L. A. STAUBER, Rutgers, The State University of New Jersey.

Variations were noted in 6 species of laboratory animals in susceptibility to the Khartoum strain of *Leishmania donovani*. Inoculation of parasites was made directly into the circulatory system (intracardial or intravenous). The numbers of parasites so injected in each case were similar and were such that they were relatively abundant in Giemsa-stained liver impression smears as soon as 1 hour after inoculation. The liver contains more than 90% of the parasites so inoculated; hence the course of the infection is followed with relative ease. Within a species very consistent results are obtained by this method, making comparisons between species highly reliable.

The white rat was found in be the most resistant host, with parasite numbers falling virtually to zero in 23 days. At the other extreme are the cotton rat and the hamster. The hamster succumbs in 35–45 days with large numbers of parasites in its liver but the cotton rat survives even larger numbers for more than 200 days. Intermediate are the chinchilla, the gerbil (*Meriones unguiculatus*), and the mouse. In all three there is an initial increase of parasites, though at a lower rate than in the hamster and cotton rat, but in both the mouse and the gerbil

this is followed by a crisis with a fall of parasite numbers almost to zero.

The curve of the numbers of parasites in the spleen generally follows that in the liver except that a much lower level of parasites is found in the spleen initially. (This investigation was supported by a research grant (E-92) from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health).

21. **Study of the Exoerythrocytic Stages of *Plasmodium gallinaceum* and *P. fallax* in Tissue Culture by Phase Contrast Microscopy.** CLAY G. HUFF, ALAN C. PIPKIN AND DINNIEMAUD V. JENSEN, Naval Medical Research Institute.

All of the stages in the exoerythrocytic cycle of these two parasites have been studied in tissue cultures of infected livers of chick embryos. Abundant growth of the embryonic cells in monolayers with large numbers of parasites has been routinely obtained for more than a year. *P. fallax* grew somewhat better and was more satisfactory for photomicrography than *P. gallinaceum*. There was a high degree of conformity between the morphology of the exoerythrocytic stages as previously studied in fixed and stained material and our observations by phase contrast microscopy on living parasites. New observations by the latter method include: (1) the presence of filamentous appendages on one end of the merozoites of both species, (2) morphological differences between the merozoites and the nuclei of schizonts of the two species respectively, and (3) the presence of mitochondria in most of the stages of both species.

22. **The Effect of Temperature of the Host on the Course of Infection of *Plasmodium cathemerium* in Duck Embryos.** R. BARCLAY MCGHEE, The University of Georgia.

Inasmuch as the avian embryo is a poikilothermic animal it became possible to study the effects of reduced temperatures on the course of infection of an avian malaria (*P. cathemerium*). In embryos incubated at 30° C the parasitemia increased slowly, albeit steadily until at 6 days infections averaged about 4000 parasites per 10,000 erythrocytes. This is in contrast to the rapid increase of parasites seen in embryos incubated at 37° or 38° C. In the latter group nearly all embryos died before 5 days. Removal of embryos from 30° to 37° C after 2 days did not appreciably alter the course of infection usually seen in embryos kept constantly at 30° C.

23. **A Comparison of the Effect of Aureomycin in Combination with Three Levels of Sulfamethazine in Feed for the Control of Cecal Coccidiosis of Chickens.** JOHN L. GARDINER, (Introduced by E. E. WEHR) Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

One-week-old chicks, inoculated with large numbers of sporulated oocysts of *Eimeria tenella*, were fed mash containing 3 levels of sulfamethazine and/or aureomycin immediately following inoculation with the coccidia, as a prophylactic measure. All 3 concentrations of sulfamethazine, 0.050, 0.075, and 0.125%, when fortified with 200 g of aureomycin per ton of mash and fed continuously throughout the experiment prevented mortality and promoted normal growth; the best growth was made and the fewest pathological changes occurred in those birds which received the highest concentration of sulfamethazine. When sulfamethazine-medicated mash without aureomycin was fed continuously for 7 days, starting at the time of inoculation, only that which contained 0.125% sulfamethazine was effective in substantially reducing clinical and pathological changes identified with coccidiosis. Following the withdrawal of the sulfamethazine-medicated mash on the 7th day after inoculation, feeding a mash containing aureomycin at a level of 200 g per ton did not promote appreciably better growth than a mash containing no aureomycin.

24. **The Effect of Furazolidone Administered in the Feed upon Coccidiosis** (*Eimeria necatrix*). ROBERT W. WOLFGANG, DOROTHY I. STUNZ AND PAUL D. HARWOOD. Hess and Clark, Inc.

Furazolidone was administered in the feed at 0.0055, 0.011 and 0.0165% to 2 replicated pens of 19 three-week-old White Leghorn cockerels. Two pens were maintained as infected and 2 as non-infected controls. Each infected bird received a *per orum* dose of 60,000 sporulated oocysts of *Eimeria necatrix*. Medication was administered immediately following the dosing. The test was terminated 10 days after dosing the birds. Total mortality and average gain for each treatment was as follows: Infected control—21 deaths and 313.9 g gain; 0.0055% Furazolidone—3 deaths and 362.0 g gain; 0.011% Furazolidone—1 death and 406.4 g gain; 0.0165% Furazolidone—1 death and 412.7 g gain. Uninfected control—no deaths and 430.1 g gain. Results of further tests will be reported.

25. **Furazolidone in the Treatment of Coccidiosis.** PAUL D. HARWOOD, DOROTHY I. STUNZ AND ROBERT W. WOLFGANG. Hess and Clark, Inc.

Furazolidone, mixed in feeds, is widely used for treatment of poultry diseases, but data on its coccidiostatic value are not published. Furazolidone and nitrofurazone are compared in chickens experimentally infected with *Eimeria tenella*. Of 19 infected, untreated controls, 8 died and survivors averaged 185 grams 11 days post-infection. Uninfected controls were 49 g heavier. Each experimental group received the medications admixed in feed the day of infection. All birds receiving 0.011 or 0.0055% of nitrofurazone or furazolidone in the feed starting on the day of infection survived. Mean weights were 20 to 40 g, per pen, greater than controls. Lower levels (0.004 and 0.0025% in the feed) did not affect mortality but improved mean weights by 14 to 30 g. All infected groups were fully resistant to challenge with 200,000 oocysts. In a floor-pen test, 150 chicks were raised from day-old to market weight in each of 12 pens. Four pens received no treatment, 4 received 0.0055% nitrofurazone in the mash and 4, 0.0055% furazolidone. Deaths from coccidiosis by treatments were 7 for the controls, 4 for nitrofurazone birds and 2 for furazolidone birds. Deaths from causes other than coccidiosis were 21 for controls, 25 for nitrofurazone birds and 22 for furazolidone birds. Average weights were 1615 g for controls, 1753 for nitrofurazone birds and 1755 for furazolidone birds. Differences in deaths between treatments are not significant; differences in mean weights between controls and treated groups are significant by the "t" test.

26. **The Role of Absorption in the Activity of Anticoccidial Agents against** *Eimeria tenella*. E. WALETZKY AND R. PROBST, Research Division, American Cyanamid Company.

Although the major portion of the coccidian life cycle is intracellular, some stages are free in the intestinal lumen of the host. Little is known on the respective contributions of unabsorbed drug in the host's intestinal lumen, and of absorbed drug present in the host's blood, to the activity of therapeutically active agents on the intra- and extracellular stages of coccidia. Direct access to material in the intestine by one of the paired ceca in the chick was prevented by ligation 24 hours after inoculation of oocysts, without altering the development of the characteristic cecal lesions produced by *Eimeria tenella* in either the ligated cecum or its unligated partner. The administration of therapeutically active anticoccidials in drug-diets was begun after ligation of 1 cecum. Comparisons will be presented on the suppression of lesions in ligated ceca, with access to drug only via the blood, and in the paired unligated ceca, with access to drug via the lumen as well as via the blood. These suggest the importance of absorption for the activity of such known anticoccidials as sulfanilamides, nitrophenide, nitrofurazone, nicarbazin and other agents in cecal coccidiosis.

27. **Effects of Standard Anthelmintics on Experimental Infections with** *Nematospiroides dubius* **Baylis in Laboratory Mice.** REDGINAL HEWITT AND ADALINE GUMBLE, Research Division, American Cyanamid Company.

The search for new anthelmintics, using small laboratory mammals for screening tests has been handicapped by the paucity of standardized host-parasite relations. The rodent helminth, *Nematospiroides dubius*, a naturally occurring trichostrongylid in wild mice, is infective to laboratory mice (Spurlock, G. M., 1943, J. Parasitol. **29**: 303–311; Baker, N. F., 1954, Proc. Book, A. V. M. A.: 185–191), but little has been published regarding its response to standard anthelmintics.

Seven out of 9 standard anthelmintics tested against experimental infections in white mice with *N. dubius* reduced significantly numbers of eggs and/or adult worms as compared with untreated controls. Carbon tetrachloride, piperazine hydrochloride, tetrachlorethylene, and toluene at 500–2000 mg/kg; phenothiazine at 2000–5000 mg/kg; hexylresorcinol at 100–250 mg/kg; and gentian violet at 25–75 mg/kg were active in single oral doses against adults. Caricide® diethylcarbamazine and n-butyl chloride were inactive at 1000–2000 mg/kg in single oral doses.

Relatively large single doses of several of the standard anthelmintics are required to produce measurable effects against *N. dubius* in white mice. This does not discourage the use of this host-parasite relation for preliminary screening since considerably smaller relative doses are active in larger mammals.

28. **Anthelmintic Effect of 'Hygromix'** (*S. hygroscopicus* **Fermentation Products, Lilly) on Helminths in Swine.** MAX C. MCCOWEN, FRANK O. GOSSETT, MAURICE E. CALLENDER AND MILO C. BRANDT, The Lilly Research Laboratories, Indianapolis, Indiana.

A crude dried broth of *Streptomyces hygroscopicus* containing hygromycin B administered in the feed of swine was found to possess anthelmintic effect on *Ascaris, Oesophagostomum* and

Trichuris. Pigs on medicated feed after 3 weeks demonstrated greatly reduced numbers of eggs for each species of parasite when compared with the control pigs. Critical examinations were conducted to evaluate further the anthelmintic properties. The medicated feed was acceptable to the swine on test and no toxic manifestations of the antibiotic were observed.

29. **Results of Feeding Small Amounts of Phenothiazine to Calves with Pure Infections of** *Cooperia punctata*. ROY L. MAYHEW, GROVER MILLER AND BETTY TORBERT, Louisiana State University.

Amounts of phenothiazine varying from 1½ g to 12 g per day have been fed in 36 experiments to a total of 7 calves. Larval counts made from the fecal samples show a very marked reduction in the number of infective larvae recovered during the periods of feeding as compared to the period the drug was not fed. Thus the level of contamination about the premises will be greatly reduced and the chances of heavy infections in susceptible animals reduced.

30. **Critical Tests on the Efficacy of Dow ET-57 as an Anthelmintic in Cattle.** HARRY HERLICH AND J. M. JOHNSON, Regional Animal Disease Research Laboratory, Agricultural Research Service, USDA, Auburn, Alabama.

An organic phosphorus compound designated as Dow ET-57, or Viozene, has been shown to be effective for the control of grubs, *Hypoderma* spp., by oral administration of the drug in cattle. Critical tests were conducted to determine the efficacy of the drug as an anthelmintic against gastrointestinal nematodes of cattle. Eight grade Jersey steers, naturally parasitized, were used, 4 of them being treated with a commercially prepared emulsion and the other 4 with a wettable powder formulation. All animals were treated at a rate of 100 mg/kg of body weight, with total dosages ranging from 5.4 to 15.25 g of the drug. The species of nematodes affected, over-all average efficacy, and range of efficacies expressed as percentage of worms removed were: *Haemonchus placei*, 98 (85–100); *Ostertagia ostertagi*, 46 (23–75); *Trichostrongylus axei*, 0.4 (0–4); *Cooperia punctata*, 59 (42–86); *Oesophagostomum radiatum*, 30 (8–88); and *Trichuris* spp., 9 (1–35). Completely unaffected were *Trichostrongylus colubriformis* and *Nematodirus helvetianus*. There was no apparent difference in efficacy between the emulsion and the wettable powder.

31. **Chemoprophylactic Action of Piperazine Dihydrochloride Against a Typhlitis in Chicks.** I. W. LARSON AND M. F. HANSEN, Kansas State College, Manhattan.

Three experiments, utilizing a total of 312 chicks, revealed promising chemoprophylactic action of this drug against a heterakid-(*Heterakis gallinarum*) associated typhlitis. The typhlitis is typical of that produced by *Histomonas meleagridis* in blackhead disease in turkeys and chickens. However, no protozoa have been isolated from the cecal contents or have been seen in stained tissue sections in these experiments.

In the 3 experiments, the ages of the chicks when fed infective heterakid eggs were 14, 21, and 28 days, respectively. The total drug dosages ranged from 250 to 2500 mg/kilo body wt. expressed as piperazine base. A tenth of each total dose was administered orally at ten different periods within 32 hours after the initial dose. In 2 experiments, the first drug dose was given 1 hour pre-exposure to infective heterakid eggs. In the third experiment, 3 groups received the first dose immediately after exposure to infective eggs and a fourth group, 30 days post-exposure.

The non-medicated, unparasitized control chicks never developed typhlitis, whereas 50% of the non-medicated, parasitized groups showed overt typhlitis. Parasitized, medicated groups receiving the drug at levels of (mg/kilo body wt., total dose) 2500, 1250, 625, 500, and 250 had only 0%, 4%, 25%, 16%, and 41% of the birds, respectively, with typhlitis. Therefore, levels above 500 mg/kilo body wt. show promise of reducing the incidence of typhlitis by 50%. The above-mentioned dosages did not reduce the number of adult or larval *H. gallinarum* below that found in the control birds. Only rarely were adult heterakids recovered from typhlitic ceca.

32. **The Control of the Swine Kidneyworm** (*Stephanurus dentatus*) **Through Management.** T. B. STEWART AND F. G. TROMBA, Animal Disease and Parasite Research Division, Agricultural Research Service, USDA, Tifton, Georgia.

Two litters of pigs were farrowed in February 1956 in a small lot previously contaminated with kidneyworm eggs. When weaned, half of the pigs were placed in clean concrete pens and the other half remained on the lot. On necropsy in August 1956, all pigs harbored kidneyworms or had characteristic kidneyworm lesions on the liver.

Two more litters of pigs were farrowed on the same lot in September 1956. Half of the pigs were placed in concrete pens at weaning and the other half remained in the lot. On

necropsy in April 1957, 1 of the 15 pigs which had remained in the lot had kidneyworm lesions in the liver; otherwise all the pigs were negative for kidneyworm.

Both groups of pigs used were first litters from gilts that were repeatedly negative for kidneyworm eggs in the urine.

Examination, by the Baermann technique, of soil samples from the lot in March 1957 yielded no kidneyworm larvae. Earthworms collected in and around the contaminated lot were all negative for larval stages of *Stephanurus dentatus*.

A program of management in which clean gilts only are used for breeding stock and used only once seems promising as a method of controlling kidneyworm in swine.

33. **The Relation of a Two-Day Pasture Rotation System to the Acquisition of Gastrointestinal Nematodes by Sheep.** RICHARD E. BRADLEY AND NORMAN D. LEVINE, University of Illinois, Urbana.

During the 1956 grazing season a pasture rotation experiment was carried out in which 11 ewes and 11 lambs were moved every other day on a fescue-alfalfa pasture, the size of the grazing area being determined by the amount the animals would eat. Three rotations were carried out, the first one lasting 50 days, the second 42 days and the third 54 days. A control group of 7 ewes and 7 lambs was maintained on an unrotated pasture of the same size and character as the rotated one.

The fecal nematode egg counts of the ewes in both groups remained low thruout the experiment. A few strongyline eggs appeared in both the control and rotated lambs 33 days after they had been placed on pasture. The strongyline eggs reached a peak of 800 eggs per gram (e.p.g.) in the control lambs in early August, 3 months after the lambs had been placed on pasture. In the rotated lambs they reached a peak of 4471 e.p.g. in mid-September, more than 4 months after the lambs had been placed on pasture. The eggs then decreased rapidly and spontaneously in both groups. Large numbers of coccidian oocysts (mostly *Eimeria arloingi*) were present in the feces of both groups of lambs; they were not associated with clinical symptoms. The rotated lambs gained an average of 0.15 pounds per day during the 146-day grazing season, while the control lambs gained 0.23 pounds per day. Pasture utilization was much better on the rotated pasture than on the control one.

34. **Comparison of the DCF and McMaster Egg-Counting Techniques as Applied to Nematode Parasitism of Sheep.** G. I. WILSON, Animal Disease and Parasite Research Division, Agricultural Research Service, USDA, Beltsville, Maryland.

Egg counts were made on 146 fecal samples taken from lambs artificially infected with *Haemonchus contortus, Trichostrongylus axei,* and *Ostertagia circumcincta,* using 2 egg-counting methods commonly employed in parasitological research, namely, the DCF method of Stoll (1930, Parasitol. **22**: 116–136) and the McMaster Helminth Egg-Counting Technique (Whitlock, 1948, J. Council Scient. and Indust. Res. **21**: 177–180). The improved McMaster slide manufactured by Hawksley and Sons, Ltd., London, was used in making the counts with the latter method. The two techniques were compared with respect to accuracy and speed.

To insure greater accuracy, duplicate counts were made on each sample examined by the DCF method. The counts obtained from 2 successive cover slips were added for each of these determinations. Both chambers of the McMaster slide were also counted for each sample. The duplicate counts by each method were averaged and the results compared. Of the 130 samples containing more than 500 eggs per gram, half were higher by the DCF method and half were higher by the McMaster method. The total number of eggs per gram for all samples was 521,454 as determined by the DCF method and 521,000 as ascertained by the McMaster technique. The difference of 0.08% was not significant. Although no absolute standard of accuracy was available, the DCF method appeared to offer greater accuracy, speed, and flexibility for low counts, particularly when differentiation of species was required, whereas the McMaster method eliminated centrifugation and was more efficient for counting specimens containing more than 2,000 eggs per gram.

35. **Notes on** *Ascaridia dissimilis.* K. B. KERR, Dr. Salsbury's Laboratories.

Specimens of large roundworms from commercial turkey flocks in Iowa, Minnesota, Illinois, Ohio, Kansas and Texas were identified as *Ascaridia dissimilis.* The species was identified by the arrangement of the papillae in the male as described by Wehr (J. Parasitol. **26**: 376). In addition, Dr. Holger Madsen of Denmark pointed out the differences in spicule shape of *A. dissimilis* and *A. galli.* This difference is also useful in identifying the species.

The life-cycle was established in our Laboratory and it was found that worm egg production started 25 to 30 days after infection. Cross-infection studies failed to establish *A. dissimilis* in chickens but *A. galli* was established in turkeys without difficulty although the degree of infection was not as great as in chickens.

36. **The Influence of Duration of Therapy and Type of Infection on the Antioxyurid Activity of Established Agents.** GEORGE M. FANELLI, JR. CHARLES H. WILLEY, New York University AND JOHN E. LYNCH, Pfizer Therapeutic Institute, Maywood, New Jersey.

It is rare that new drugs intended for anthelmintic usage can be initially evaluated against parasites of medical and/or economic importance in laboratory animals. More often, related helminths of rodent hosts are used for initial screening tests. *Syphacia obvelata* is widely used in laboratory tests because of its morphological relationship to the human pinworm *Enterobius vermicularis*.

In screening tests, individual laboratories have usually employed variable treatment schedules against different types of *S. obvelata* infections in mice when evaluating new compounds. The present study was undertaken to determine the influence of duration of therapy and type of infection on the efficacy of established antioxyurid agents. The drugs used were piperazine citrate, Parvex, (betaine of piperazine dithiocarbamic acid) phenothiazine and gentian violet. Each drug was evaluated after 1 through 8 daily oral treatments at levels of 250 mg/kg and 125 mg/kg except in the case of gentian violet which was studied at 35 and 15 mg/kg of body weight.

The efficiency of piperazine citrate and Parvex increased stepwise with each daily treatment; phenothiazine was without appreciable effect and gentian violet was effective but, at the levels used, proved to be toxic after 5 treatments. The duration of therapy influences appreciably the effectiveness against *S. obvelata* in mice. In these experiments a mixed infection was evident even though the ratio of mature to immature forms was variable and conceivably did influence some of the therapeutic results. Standardization of dosage regimens in different laboratories is desirable when evaluating antioxyurid compounds.

37. **Observations on the Arrested Development of Cattle Nematodes.** H. H. VEGORS. Regional Animal Disease Research Laboratory Substation, Agricultural Research Service, USDA, Experiment, Georgia.

In each of 2 successive years 4 yearling grade Herefords were taken from pasture in late spring, placed in a barn, and fed hay or hay and grain for 30 days. Daily cleansing of the stalls prevented further exposure to parasitism. Combining both years' results, we recovered an average of 3,200 fourth-stage larvae (mostly *Ostertagia ostertagi*) from the stomachs of the animals and an average of 200 fourth-stage larvae of *Cooperia* spp. from the intestines. This represented one-half and one-fifth, respectively, of the numbers of larvae recovered from the stomachs and intestines of comparable animals from pasture, which were necropsied at the beginning and end of the barn tests.

These results indicate that a considerable number of the larvae present in the cattle when they were placed in the barn did not mature in the normal period of prepatency, but were inhibited in their development. Among other factors, this may possibly be due to immunity exhibited by the animals.

38. **Survival of *Ancylostoma caninum* and *Taenia pisiformis* in Thiry Fistulae of Dogs.** GEORGE GAROIAN, Southern Illinois University.

An isolated segment of jejunum was obtained by doubly transecting the small intestine of a dog about 12 inches apart. Intestinal continuity was re-established by joining the two ends. A Thiry fistula was prepared from the isolated segment. For this, one end of the segment was sewn closed and the other connected to the exterior through a small hole in the flank. The blood and nerve supply to this isolated segment was not altered.

Infective larvae of *Ancylostoma caninum* placed into the fistula developed to maturity. Viable eggs first appeared in the fistular fluid about 25 days after infection. Living adults were found in the fistula when the experiment was terminated 94 days after infection. Since no hookworms were found in the intestine it appears that these larvae do not circulate in the blood stream when they invade the mucosa.

When adult *Taenia pisiformis* were transferred into Thiry fistulae, they survived no longer than 7 days. With the daily addition of carbohydrate (soluble starch and dextrose), survival increased slightly to no longer than 9 days. When normal intestinal contents were added daily the tapeworms remained throughout the test period of 14 days. In all cases, however, strobilae were lost within 2 or 3 days.

39. **Comparative Studies on Amino Acid Absorption by Cestodes.** JACK W. DAUGHERTY AND WILLIAM B. FOSTER, Rice Institute.

Like all animals, cestodes are totally dependent, directly or indirectly, on their environment for all the materials required for growth, reproduction, and energy metabolism. In the absence of an alimentary tract or any known specific openings through which these substances

can pass to the interior of the worm, the integument must assume the entire function of absorption.

In the present experiments, a study was made of the absorption of certain amino acids by the chicken tapeworm, *Raillietina cesticillus*. This study was undertaken principally to determine the general applicability to other cestodes of the results that were obtained in earlier studies on *Hymenolepis diminuta*. At the same time, it was hoped that, although the nature of the absorption processes in the two worms might be similar, the kinetics would be sufficiently different to give additional information on the mechanisms involved. Both expectations were, in part, realized. The data obtained from the comparative study of the two worms, from temperature studies, and from competition studies leave little double that methionine, alanine, valine, glycine, and serine are absorbed by both cestodes by mechanisms that depend on physiological factors. As adjudged by the findings, these factors most likely influence the transport of the compounds across the integument of the worms. The exact nature of this relation is not yet known. Glutamic acid and aspartic acid were observed to be absorbed by the worms by mechanisms that are apparently different from that for the neutral amino acids. At physiological temperatures the chicken cestode was observed to have 4 to 6 times the activity of the rat parasite in its absorption of neutral amino acids.

40. **Helminth Amino Acid Metabolism. I. Comparative Studies on *Raillietina cesticillus* and *Hymenolepis diminuta*.** WILLIAM B. FOSTER AND JACK W. DAUGHERTY, The Rice Institute.

The establishment and distribution of *Raillietina cesticillus* in White Rock chickens was followed for 0, 1, 2, 5, 8, 11, 14, and 17 days after inoculation. The cestode was found to first establish anterior to the opening of the bile ducts before moving posterior to this point where it was distributed along the first 14 cm for the remainder of its adult life. These movements are contrary to those found for *Hymenolepis diminuta* and *Moniliformis dubius*.

Chromatographic analysis of the free amino acid and protein fractions of *Raillietina* and *Hymenolepis* showed the latter to contain a larger amount of free amino acids and related substances, especially taurine, while the former had much more proline. *Hymenolepis* contained 5 freely occurring amino acids in addition to those found in *Raillietina*. The protein hydrolysates of the two cestodes were quantitatively similar, but qualitatively *Hymenolepis* also contained cystine.

The following transaminase reactions were found in both cestodes: glutamate to aspartate and aspartate to glutamate, alanine to glutamate and glutamate to alanine, in order of decreasing activity for *Raillietina*. In all but the last system the amount of activity in *Hymenolepis* was double that of *Raillietina*. The glutamic dehydrogenase activity in *Hymenolepis* homogenates was also greater.

41. **Effect of High Temperatures on Development of Cestode Larvae of the Genus *Hymenolepis*.** M. VOGE AND D. HEYNEMANN, University of California, Los Angeles.

Experiments dealing with the effect of high temperatures on *Hymenolepis nana* and *H. diminuta* showed that cysticercoids of *H. nana* will develop normally at environmental temperatures as high as 40° C, while *H. diminuta* larvae may have abnormal features when kept at 37° C, and are all abnormal when developing at 38.5° C. In *H. diminuta* larvae, withdrawal of the scolex may be delayed or prevented at 37° C and is almost always inhibited at 38.5° C. Structural abnormalities seen at this temperature include incomplete development of the scolex and suckers. In *H. nana*, abnormal features produced at 41–42° C include abnormal growth, incomplete development or absence of outer membranes, and abnormal position of the withdrawn scolex. Body size attained by cysticercoids of both species is considerably smaller at high temperatures than it is at optimal or low temperatures. Small body size is primarily due to a reduction in tail size, as the tail is usually quite small or absent entirely when development takes place at high temperatures, regardless of the length of time cysticercoids are kept after development has been completed.

42. **The Excystment of Tapeworm Larvae.** ALVIN H. ROTHMAN, Department of Pathobiology, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland.

Larvae of *Hymenolepis diminuta, H. citelli*, and *H. nana* were reared in adults of the flour beetle, *Tribolium confusum*. Larvae of *Oochoristica symmetrica* were reared in the larval beetles of *Trogodema* sp. The cysticercoids were dissected from the beetles and rinsed 3 times in Ringer's solution. The substance(s) to be tested were dissolved in a Krebs Ringer's Phosphate solution (KRP) to give a final pH of 6.7. The larvae in the test solution were placed on a cover slip which was inverted on a welled slide. The experiments were performed at room temperature or at 37° C and the larvae observed with a dissecting microscope.

Larvae of *O. symmetrica* and *H. nana* were activated at room temperature (22–26° C) by bile salts (sodium cholate, glycocholate, or taurocholate) but only the larvae of *O. symmetrica* excysted. The larvae of *H. diminuta* and *H. citelli* were not activated by bile salts at room temperature. All 4 species were activated by bile salts at 37° C but only *O. symmetrica* and *H. diminuta* excysted. Age of the cysticercoid did not affect the excystation rate of *O. symmetrica* but with aging there was a decrease in the rate of excystation of *H. diminuta.*

The addition of trypsin to the bile salt KRP solution caused the excystation of all the larvae tested. Pretreatment of the larvae in a pepsin solution enhanced the excystation rate of the 3 hymenolepidid species in the trypsin-bile salt solution. (This investigation was carried out under the direction of Dr. Clark P. Read and was supported in part by a research grant (E-1508) from the National Institutes of Health, U. S. Public Health Service.)

43. **Investigations on the Use of X-irradiation as a Mechanism for Facilitating the Study of Morphological Variation in** *Hymenolepis nana.* E. L. SCHILLER, The Johns Hopkins University.

The major limitation in the analysis of variation by comparative morphological studies is encountered in the laborious process of examining the great number of specimens required to detect important changes ordinarily occurring at a low frequency. X-rays and other ionizing radiations increase the frequency of the same kinds of mutations which occur spontaneously. Present knowledge indicates that the rise in the rate of mutation is directly proportional to the radiation dose. This proportionality was the basis for investigations concerning the use of X-irradiations as a mechanism for facilitating the study of morphological variation in *Hymenolepis nana.*

By determining the frequency with which observable mutant characters occurred in the strobilae of cestodes obtained from Princeton Swiss mice experimentally infected, both directly and indirectly, using eggs which had been exposed to different amounts of X-irradiation ranging from 5 to 40 kilo-roentgens, it was found that, within the error of the experiments, the yield of mutations is directly proportional to the roentgen dose. When plotted graphically, extrapolation of the line expressing this relation to the ordinate representing zero irradiation gives an estimate of the frequency with which the character in question can be expected to occur in the non-irradiated population. When the estimates obtained by this method were checked by actual determinations based on a large series of non-irradiated specimens of *H. nana,* there were no statistically significant differences between the estimated and the determined rates. In addition, the slope of the line provides an estimate of the range over which the organism has the capacity for expressing a particular condition. For taxonomic purposes, this appears to be useful in evaluating the relative stability of any given morphological character.

44. **The Differentiation of** *Hymenolepis diminuta* **and** *H. citelli.* C. P. READ, A. H. ROTHMAN, AND K. PHIFER, The Johns Hopkins University.

There have been continued expressions of doubt that *Hymenolepis citelli,* from ground squirrels, is specifically distinct from *H. diminuta,* a cosmopolitan cestode in rats. In the present study, these worms have been compared in terms of (1) the details of larval development, (2) the growth of the strobila in different host species, (3) the pattern of growth in the same host individual, (4) the modes of egg liberation, (5) the characteristics of carbohydrate metabolism, (6) the effects of inhibitors of metabolism, (7) certain details of electron transport, and (8) effects on the worms of alterations of the host diet. The data presented show that the worms differ significantly in each of these categories. It is concluded that *H. citelli* and *H. diminuta* are distinct species.

45. **Studies on the Embryonic Development of a Proteocephalid Tapeworm.** R. E. OGREN, Ursinus College, Collegeville, Pa.

Specimens of *Proteocephalus* sp. were sectioned and the course of embryonic development studied. The oocyte, when the sperm entered, was without large masses of vitelline substance. Meiosis was followed by an equal cleavage. The shell capsule was constructed in the uterus. All blastomeres formed the morula. The embryonic epidermis of the morula became the embryophore and was separated early from the inner cell mass. The oncosphere developed from this latter group of cells. The oncosphere was composed of muscular parenchyma cells and contained 6 hooks and several plastin cells. Epidermal glands and flame cells were absent from the oncosphere. Suggestions for a comparative study of metacestode stages are presented. The comparative time in the metacestode for the appearance of the sucker primordia, excretory ducts and flame cells should be learned for a large group of cestode genera. In general the Pseudophyllidea show an early appearance of flame cells and excretory system and a late appearance of sucker primordia. The known genera of Cyclophyllidea show an early appearance

of sucker primordia, but a late appearance of the excretory system. The intermediate condition of the proteocephalids indicates they need more careful study. Further systematic correlations will result from such studies.

46. **The Spermatogenesis of Two Nematotaeniid Cestodes.** L. T. DOUGLAS, Emory & Henry College.

In the two species studied, *Baerietta diana* (Helfer 1948) and *Distoichometra kozloffi* sp. nov., maturation occurs in nuclei located in syncytial masses. The 2 divisions begin in 16 primary spermatocytic nuclei. The prophase of the first maturation division takes place in all 8 nuclei simultaneously, and the syncytial mass subdivides into individual cells at the metaphase. During late telophase, without completing cytokinesis, the 8 binucleate masses reunite to form an aggregate of 32 secondary spermatocytic nuclei. These 32 nuclei then form 64 spermatid nuclei in much the same way as they themselves were produced.

Spermiogenesis can best be studied by using the Feulgen technique together with silver impregnation. The nuclei gradually elongate into a filiform spiral shape. The middle-piece is single and is composed of an axoneme together with a middle-piece spiral.

47. **Fertilization, Maturation, and Early Cleavage in** *Baerietta desmognathi sp. nov.* **(Nematotaeniidae).** L. T. DOUGLAS, Emory & Henry College.

The filiform nucleus wraps around the primary oöcyte and enters the cytoplasm of the latter. The method of penetration has not been determined, but it seems that the entire length of the sperm nucleus penetrates through 1 opening. Immediately after sperm penetration (or perhaps even upon sperm contact), the bivalents of the primary oöcyte appear in diplotene (development through the pachytene occurs in the ovary while sperm penetration begins in the oviduct).

Each oöcyte (with exceptions) entering the uterus has been penetrated by a sperm nucleus and has united with 1, 2, or 3 yolk cells. The remainder of embryonic development occurs in the uterus and parauterine organs.

During diakinesis and metaphase 4 bivalents can be counted in one strain and 8 in another. The polar bodies are formed adjacent to the yolk cell and often appear as swellings on the ends of cytoplasmic peduncles which extend from the oöcytes.

Cleavage has been studied through the 5-cell stage. The first cleavage is slightly unequal, resulting in a large and a small macromere. The following 3 blastomeres are formed alternately by the 2 macromeres: 2 micromeres by the large macromere and 2 mesomeres by the smaller macromere. The first 5 blastomeres are thus formed in the following sequence: 2 macromeres, 1 micromere, 2 mesomeres (eliminating the smaller macromere), 1 micromere.

The only difference between the early cleavage pattern of *B. diana* (occurring in *Batrachoseps attenuatus*) and *B. desmognathi* (occurring primarily in *Desmognathus fuscus fuscus*) is the unequal first cleavage in the latter.

48. **The Effects of Concurrent Infections with the Spiny-headed Worm,** *Moniliformis dubius,* **on the Rat Tapeworm,** *Hymenolepis diminuta.* JOHN C. HOLMES, The Rice Institute.

The effects of double infections with *Hymenolepis diminuta* and *Moniliformis dubius* on the percentage of worms recovered and the lengths, wet weights and distribution within the host small intestine of these worms has been studied in Sprague-Dawley rats and in hamsters.

Hymenolepis developing in double infections in rats are markedly displaced posteriorly in the gut, occupying a position posterior to most of the *Moniliformis*. These tapeworms are significantly shorter and lighter and have longer prepatent periods than those developing in single infections. No such posteriorly directed displacement or protraction of the prepatent period occurs in hamsters. Tapeworms developing in double infections in hamsters are larger than the controls. Approximately the same percentage of the administered larvae were recovered as mature worms in the two host species, and the worms in the singly infected hosts were of approximately the same size.

A higher percentage of the *Moniliformis* became established in rats given simultaneous or previous infections with *Hymenolepis* than in rats given *Moniliformis* alone or prior to the tapeworms, but the *Moniliformis* developing in double infections are somewhat displaced anteriorly and are significantly lighter than those developing in single-species infections. The slight shift anteriorly does not occur in double infections in hamsters. The worms are the same size or larger than the controls, and no enhancement of the percentage of the worms recovered due to the presence of *Hymenolepis* was found in these hosts.

49. **A Study of the Distribution of Acid and Alkaline Glycerophosphatase Activity in the Cestode** *Hymenolepis nana.* J. H. GILFORD, Gettysburg College.

Sites of acid and alkaline glycerophosphatase activity have been studied in *Hymenolepis nana* using modifications of Gomori's technics for the demonstration of acid and alkaline phosphatases. For the histochemical demonstration of alkaline glycerophosphatase, 0.03M sodium glycerophosphate in a sodium barbital buffer (pH 9.5) was used as a substrate. Insoluble phosphates formed by enzyme activity were demonstrated as colbalt sulfide when treated with colbalt chloride and ammonium sulfide. Sodium glycerophosphate (0.03M) in an acetate buffer (pH 5.0) was used as a substrate in the technic for demonstrating sites of acid phosphatase activity. Insoluble phosphates formed as a result of enzyme activity were demonstrated as lead sulfide deposits following treatment with lead nitrate and ammonium sulfide. Sections inactivated by boiling water or incubated in the appropriate buffer solutions without substrate were used as controls.

Alkaline glycerophosphatase activity was strongest in the cuticle and subcuticular layers of adult worms. Little or no activity was demonstrated in sites other than those just indicated. The cuticle and subcuticular layers appear to be free of acid phosphatase activity while the reproductive organs, ova and sperm show sites of high enzyme activity.

Both acid and alkaline glycerophosphatase activity was demonstrated in cysticeroids obtained from infected beetles, *Tribolium confusum*. Alkaline glycerophosphatase activity was strongest in the inner layer of the cyst wall and in the cuticle and subcuticular layers of the larval tapeworms. Certain large cells associated with the scolex and suckers also showed enzyme activity. Acid glycerophosphatase activity was strongest in the parenchyma of the larval cestodes with only weak activity in the subcuticular regions and no demonstrable activity in the cuticle and cyst wall.

If phosphatase activity is involved in the absorption of glucose, the alkaline phosphatase activity of the cuticle and subcuticular layers is particularly interesting in view of Read's findings (Exper. Parasit. **5**: 325–344) concerning the utilization of carbohydrates by various cestodes. (This study was conducted through the aid of a Lalor Foundation research fellowship.)

50. **Aldolase in the Larval Form of *Taenia crassiceps*, Rudolphi 1810.** K. PHIFER, The Johns Hopkins University.

Since relatively little information on the intermediary metabolism of tapeworms is available and virtually none concerning characterization of specific enzymes, a study was made of aldolase from *Taenia crassiceps* larvae, including a comparison of certain of its physical properties with those of mammalian and protozoan aldolases.

Aldolase from *T. crassiceps* is a soluble enzyme with no functional sulfhydryl groups and remains stable in KCl solution for up to 5 months at $-20°$ C. It is not activated by ferric, cobaltous, magnesium, stannous or nickel ions and its activity is not significantly affected by chelating agents. The Michaelis constant was found to be 9.5×10^{-3}M and the optimum pH for aldolase activity is 8.5 to 9.0. The much closer similarity of these two latter values to those for mammalian aldolase than to the corresponding values for the protozoan enzyme may indicate that a tapeworm enzyme is much closer to that of mammals than to that of protozoa. Work is currently under way in which this enzyme from closely related species of helminths is being studied immunologically.

51. **Enhancement of the *in vivo* Schistosomacidal Activity of Antimony Compounds by Glycerol.** GEORGE W. LUTTERMOSER, Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Maryland.

Several adjuvants were administered singly with tartar emetic to mice infected with *Schistosoma mansoni*. Of these, glycerol was the only adjuvant which appeared to enhance the activity of this drug when both were given orally. It was found that there was a 71.9% reduction in the schistosome infection of 21 mice which had received tartar emetic in 50% glycerol, while only a 43.6% reduction occurred in 22 mice given the tartar emetic alone. This difference in activity approached significance.

The drug, stibophen (Fuadin), was administered intraperitoneally, alone and in combination with glycerol or 1 of several adjuvants. Only glycerol enhanced the activity of stibophen. There was a 79.7% reduction in the schistosome infection of 39 mice which were treated intraperitoneally with stibophen in 25% glycerol, while there was a 32.3% reduction in the worm burden of 38 mice treated with the drug alone in physiological saline. This difference was significant. No "kill" of parasites was observed in the control mice given 50% glycerol orally or 25% glycerol intraperitoneally. The schistosomacidal activity of a third antimony compound was likewise increased by combination with glycerol. In preliminary tests, there appeared to be a slight increase in the toxicity of tartar emetic and stibophen when they were administered as glycerol solutions.

The possibility of the glycerol enhancement of the activity of Miracil is also under study.

52. **Experimental *Schistosoma mansoni* Infections in Rhesus Monkeys with Particular Reference to Chemotherapy.** HAIG H. NAJARIAN, DUNCAN MCCARTHY*, BRONISLAWA OLSZEWSKI, ANITA BAYLES, AND PAUL E. THOMPSON, Parke, Davis and Company, Detroit, Michigan.

Among 45 monkeys (2.5–4 kg) exposed percutaneously to 1000 cercariae, all became infected. A cercarial dermatitis persisted at the exposure site through 24 hours. The ensuing infections usually were tolerated well, but occasionally seemed to be too severe for the smaller animals. Eggs appeared in the feces as early as 37 days and at 8 weeks ranged from about 200–1800/ml of displaced feces (acid-ether technic). The number of eggs per unit sample in a 24-hour period varied more than replicate counts of aliquots from the same sample. A rapid hatching technic was developed and proved to be much more sensitive than microscopic examinations for eggs by the acid-ether method. Observations on a few animals showed 150–200 worms (sex ratio about 1.5 male : 1 female) with a persistence of living worms through 14 months after exposure. In untreated mature infections, most of the worms were in the superior and inferior venous plexi, hepatic egg lesions were numerous, and grossly visible intestinal lesions were almost completely restricted to the large bowel.

Therapeutic tests have been conducted in the following manner: Egg densities in the feces are ascertained prior to treatment; therapy is usually by gavage for 1 to 4 weeks and is restricted to the 2nd through the 5th month after infection so as to assure the exposure of the mature worms to drug without the complication of detectable acquired immunity; egg-production is followed quantitatively semi-weekly; host reactions are recorded daily; when stools are negative for eggs (4 consecutive examinations by acid-ether and hatching) at least 1 month after the end of treatment, the animal is perfused and examined for egg lesions and for living and dead worms. These methods permit the appraisal of either partial effect or complete cure.

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53. **Studies of Schistosomiasis mansoni in Primates. (1) Initial Occurrence of Serologic Antibodies Correlated with Egg Recovery.** DAVID H. NAIMARK, JOSE OLIVER-GONZALES, ELMER F. CHAFFEE AND ROBERT I. ANDERSON, U. S. Army Tropical Research Medical Laboratory and University of Puerto Rico, School of Medicine and School of Tropical Medicine, San Juan, Puerto Rico.

A continuing study of acquired resistance in the primate *Macacus rhesus* experimentally infected with *Schistosoma mansoni* afforded the opportunity to determine the relation between initial exposure and the time when stools and serologic tests become positive.

Monkeys were exposed to 3 different dosage levels of cercariae: (1) a single exposure of 1000 mixed cercariae, (2) a single exposure to 500 mixed cercariae, and (3) multiple monthly exposures to 25–50 cercariae each. Stools were collected every 2–3 days and examined for eggs. Cercarial agglutination, circumoval precipitation, and complement-fixation tests employing antigens from the adult and cercarial stages were performed usually on weekly serum specimens. In general, by the time that any of the serologic tests became positive, the stool had already contained eggs. It is of interest that the 3 different types of exposure apparently did not produce statistical differences in the interval between initial exposure and the time when the serologic tests and stools became positive. The time of first appearance of eggs in the stools for all monkeys regardless of the type of exposure was 41.5 days with a standard deviation of 3.53. The best results in the serologic tests were demonstrated by the cercarial agglutination procedure; an average of 41.4 days with a standard deviation of 10.03 was obtained. It appears that serological procedures have no advantage over stool examination as far as early diagnosis of schistosomiasis is concerned.

54. **A Perfusion Procedure (PERF-O-SUCTION) for Recovery of Schistosome Worms.** MYRON G. RADKE, LUIS A. BERRIOS-DURAN, AND KENNETH MORAN, U. S. Army Tropical Research Medical Laboratory, San Juan, Puerto Rico.

Certain innovations have been incorporated into the basic plan of perfusion, reducing the time required for recovery of schistosomes. These include a special perfusion board, ex-sanguination of animals prior to perfusion, use of the Brewer (Model 40) automatic pipetting machine for supplying pressure and a suction device for retrieving worms.

Plastic autopsy boards (15″ × 30″ × ¼″) have been constructed to hold a series of anesthetized animals, either 5 mice or 3 hamsters, which are held by their feet by bolted plastic clothes pins. Dual series of perforations alongside each animal afford drainage of excess fluids into underlying tray(s). Ex-sanguination by heart puncture, using a collecting bottle on a vacuum line, reduces the burden of worm-washing and eliminates perfusate-clotting. The body is left intact, except for a ventral incision and removal of one-half the thoracic cage, the

other half acting as anchorage for the needle while injecting the hepatic sinus (liver perfusion); the thoracic aorta serves for intestinal perfusion. No ligations, or hemostatic closures are required for blood vessels of mice and hamsters. The action of the pipetting machine which supplies saline pressure for injection is controlled by a foot pedal, thus freeing both hands. Machine settings, utilizing a 20-ml syringe in "position one, line 2, 30°" with a motor setting of "H", are optimal for mice and hamsters, while for larger animals a 20-ml syringe is used in "position two, line 2, 30°" with a motor setting of "K". Worms forced from the severed hepatic portal, first from the liver and then the intestine, are picked up by a suction device, involving a 1,000-ml separatory funnel containing 200 ml of saline. The separatory funnel has an exhaust outlet connected to a vacuum line; also an intake tube, the inner end of which extends ¼ inch below the saline level, while the free end is fitted with a short notched piece of 2-mm glass tubing for sucking up the worms. The worms can be withdrawn from the separatory funnel into petri dishes for counting.

55. **Further Studies on the Size and Shape of the Eggs of the Geographical Strains of *Schistosoma japonicum*.** H. F. Hsü and S. Y. Li Hsü, State University of Iowa.

Thirty mice were infected with each of the 3 strains, Chinese, Formosan, and Japanese; and 7 were infected with the Philippine strain. A mean of the length, width, and index of 50 mature eggs was obtained from each host-individual. The mean of the 30 means of 50 eggs from 30 mice was obtained. Using the small sample theory, the 99% confidence limits for the true mean of the means was established. Those of the length were 81.5 to 83.4 microns for the Japanese strain, 82.5 to 84.2 microns for the Formosan, 81.3 to 85.9 microns for the Philippine, and 85.8 to 87.2 for the Chinese; those of the width, 56.6 to 57.6 microns for the Chinese, 55.4 to 61.4 microns for the Philippine, 60.6 to 61.7 microns for the Formosan, and 61.9 to 63.1 microns for the Japanese; and those of the index, 65.4 to 66.9 for the Chinese, 67.7 to 72.3 for the Philippine, 72.8 to 73.9 for the Formosan, and 75.2 to 76.7 for the Japanese.

The confidence limits of the mean of the means of the length or width of the eggs were overlapped to a certain extent between certain strains. Those for the index, however, were very distinct, i.e., there was no overlapping among the 4 strains.

56. **Alterations in Serum Glutamic-Oxaloacetic Transaminase (SGO-T) in the Course of Experimental Schistosomiasis mansoni.** Seymour Garson, Alexander Duran and Joseph S. Williams, U. S. Army Tropical Research Medical Laboratory, San Juan, Puerto Rico.

Elevations of SGO-T, occurring particularly in certain cardiac and hepatic disease states, are roughly proportional to the extent of associated cellular injury (Wroblewski, 1956). In the present study, SGO-T elevations were observed in male mice harboring bisexual *Schistosoma mansoni* infections of 2 to 10 weeks' duration at the 125-cercariae level. Blood was obtained from the external jugular vein. Mean levels of SGO-T (units/ml) ± S. E. were as follows: controls, 54 ± 4.6; 2 weeks, 76 ± 4.1; 4 weeks, 121 ± 7.3; 6 weeks, 153 ± 5.9; 8 weeks, 193 ± 12.3; 10 weeks, 157 ± 14.9. Differences between mean SGO-T for the controls and each experimental group are statistically significant. Except for the apparent decrease at 10 weeks, mean SGO-T differences between succesive experimental groups are also significant. Sample worm recoveries obtained from each of the experimental groups were essentially commensurate. An increased resistance to further tissue alteration is, therefore, suggested in mice surviving beyond 8 weeks. Peak SGO-T activity observed at 8 weeks coincides, apparently, with the deposition of numerous eggs in the liver. Observations in mice harboring unisexual worm infections are in progress; tentative indications are that significant elevations in SGO-T, as observed, for bisexual infection, do not occur in male worm infections of 2 and 4 weeks' duration, although a decided rise in the serum enzyme exists at 6 weeks. Rabbits exposed to 5000 pooled cercariae and presumably harboring bisexual infection have not shown significant elevations in SGO-T at 1, 2, 4 and 6 weeks following exposure.

At this time, the above results appear to support the contention of some investigators that the presence of both worm sexes in a suitable host, such as the mouse, elicits a more deleterious effect on the liver in early stages of the infection than the presence of a single sex.

57. **Transamination in *Schistosoma mansoni*.** Seymour Garson and Joseph S. Williams, U. S. Army Tropical Research Medical Laboratory, San Juan, Puerto Rico.

The reactions catalyzed by transaminases, namely, those involving the transfer of an amino group from an alpha-amino acid to an alpha-keto acid, are believed to play an important role in nitrogen metabolism. The scope and relative intensities of such reactions occurring in adult male *S. mansoni* were studied by means of cell-free worm homogenates. Transamination, in

serial order of decreasing activity, was observed between alpha-ketoglutaric acid and the amino acids, alanine, arginine, aspartic acid and glycine. Pyruvic acid-amino acid transamination was evident only when glutamic acid served as the amino group donor. The higher rate and wider scope of transamination reactions observed with alpha-ketoglutaric acid are generally comparable to the situation reported for most vertebrate tissues and suggests that this keto acid may play a significant role in the metabolism of *S. mansoni*. The contention of Read (1956) that some intermediates for synthesis may be furnished by aerobic processes in an organism such as *S. mansoni* which is not primarily dependent on aerobic metabolism as an energy mechanism, is worthy of further consideration with regard to keto acids in *S. mansoni*. In light of the relatively small quantity of free arginine evident in adult worm tissues, as previously determined by paper chromatographic analyses, the moderate rate of activity obtained with this amino acid and alpha-ketoglutaric acid is viewed with interest.

58. **Intradermal Tests and Their Usefulness in the Field for the Detection of Schistosomiasis japonica, Paragonimiasis and Clonorchiasis.** GEORGE W. HUNTER, III, L. S. RITCHIE, C. PAN, S. LIN, S. SUGIURA, K. NAGANO, AND M. YOKOGAWA, 406th Medical General Laboratory, Tokyo; Yamanashi Medical Research Institute, Kofu; Kitasato Institute, Tokyo; Japanese Institute of Public Health, Tokyo.

Antigens prepared from adult *S. japonicum* (also cercariae), *P. westermani*, and *C. sinensis* were tested in a 1:10,000 dilution on known positives and negatives as follows: (1) 298 positive for *S. japonicum* gave 94.6% positive reactions while 202 controls yielded 6.9% false positives; (2) 95.6% of 113 positive for *P. westermani* reacted positively while all 60 controls were negative; (3) 64.7% of 136 passing *C. sinensis* eggs reacted positively while 17.3% of 58 gave false reactions; (4) 5.1% of 79 with *P. westermani* produced false positive reactions with *S. japonicum antigen* while 4.7% of 129 with *C. sinensis* did the same; (5) 4% of 99 with schistosomiasis gave false reactions when tested with *P. westermani* antigen, but *Clonorchis* patients were not tested; (6) with *C. sinensis* antigen 8.7% of 92 with schistosomiasis and 44.7% of 47 with paragonimiasis gave false positive reactions. Thus it appears that the *S. japonicum* and *P. westermani* antigens at a 1:10,000 dilution hold promise of being a useful diagnostic aid and epidemiologic tool, while *C. sinensis* antigen is unsatisfactory and needs further study.

59. **The ecology of marine dermatitis-producing schistosomes. III. Oxygen consumption of normal and parasitized** *Nassarius obsoletus* (*Nassa obsoleta*) **under varying conditions of salinity.** CARL SINDERMANN AND AARON ROSENFIELD, Fisheries Research Station, Boothbay Harbor, Maine.

With the observation that the salinity of the external environment of the snail host markedly influences the rate of emergence of cercariae of *Austrobilharzia variglandis* (Sindermann, Rosenfield, and Strom, J. Parasitol., in press), and with the probable close relation of the metabolism of the snail host and that of its larval trematode parasites, measurements have been made of the oxygen consumption of normal and parasitized *Nassarius* at salinities from 0 to 35 parts per thousand, for periods extending up to 1 week. Both normal and parasitized snails exhibited a remarkably similar general pattern of response to salinity, with greatest oxygen consumption between 15 and 25 parts per thousand, and with greatly reduced consumption below 10 parts per thousand. Transfer of snails to salinities below 10 resulted in almost immediate decline in oxygen consumption, with the depressed level being maintained while snails remained in the lowest salinities. Massive tissue hydration also characterized snails maintained at salinities less than 10 parts per thousand.

60. **Some Reflections on the Ecology of Parasitism.** GILBERT F. OTTO, Abbott Laboratories, North Chicago, Illinois.

(Presidential Address)

61. **Technical Procedures for Tissue Culture Propagation and Phase Contrast Photomicrographic Studies of Exoerythrocytic Stages of** *Plasmodium gallinaceum* **and** *P. fallax*. ALAN C. PIPKIN, CLAY G. HUFF AND DINNIEMAUD V. JENSEN, Naval Medical Research Institute.

The photomicrographic study by phase contrast of the morphology of the exoerythrocytic stages of *Plasmodium gallinaceum* and *P. fallax in vitro* has required adaptation of tissue culture techniques to insure dependable routine production of these parasites in monolayers of embryonic chick cells. The techniques used included serial passage of the strains of parasites from embryonic brain to chorio-allantoic membrane, trypsinization of infected embryonic

tissues, and mechanical homogenization into small cell aggregates capable of producing prompt outgrowth of infected monolayers of embryonic cells. Development of special culture flasks with demountable bottoms which could be removed and reassembled either as part of conventional perfusion chambers, or viewed as temporary vaseline-sealed mounts, made possible the extended observation of the living cells and their contained parasites as they developed. Graphic representation of the routine procedures as well as a demonstration of equipment used, and photomicrographs of the different stages of the parasites as seen *in vitro* are presented.

62. **A Fourth Species of *Neoechinorhynchus* (Acanthocephala) in Turtles of the United States.** R. M. CABLE AND F. M. FISHER, JR., Purdue University.

Acanthocephalans from North American turtles were regarded as a single species, *Neoechinorhynchus emydis,* until Cable and Hopp (J. Parasitol. **40**: 674–680, 1954) reported that 3 species parasitize as many species of turtles in northwestern Indiana. A fourth species has been found in *Pseudemys scripta troosti* from the Mississippi River in Arkansas. The turtles harbored also *Neoechinorhynchus pseudemydis* and *N. chrysemydis,* thus showing that host specificity is by no means as rigid as Cable and Hopp observed but demonstrating that differences between the reported species cannot be attributed to development within different host species.

The new form can be distinguished most readily by the size and structure of the fully developed eggs. It is similar to *N. emydis* in the contour of the posterior end of the female but differs from that species in the width of the uterus and certain other dimensions.

63. **Ultra-structure of *Rhabditis strongyloides.*** C. ROBERT PEEBLES, University of Illinois. (See Abstract no. 120.)

64. **Filarial Parasites of the Rice Rat.** J. ALLEN SCOTT, ETTA MAE MACDONALD AND JOHN H. CROSS, JR., The University of Texas Medical Branch at Galveston.

Specimens of filarial worms from the rice rat, *Oryzomys palustris palustris,* are demonstrated. Their taxonomic status is undecided. Morphologically, they appear to be either identical to *Litomosoides carinii* or a new closely related species. They can be readily transmitted to rice rats of the subspecies *O. palustris palustris* by the tropical rat mite, which is the vector of *L. carinii* for the cotton rat. On the other hand it has not been possible to transmit these worms to rice rats of the subspecies *O. palustris natator.* Neither is it possible to transmit them to cotton rats, nor to transmit *L. carinii* from the cotton rat to either subspecies of rice rat. (Supported by National Science Foundation Grant 1213.)

65. **Nematodes in Grand Canyon Rodents: *Syphacia, Gongylonema,* and *Rictularia.*** F. J. KRUIDENIER AND C. R. PEEBLES, University of Illinois.

During a 1954 University of Illinois Natural History Museum expedition to the Grand Canyon, Coconimo County, Arizona, a total of 396 mammals was autopsied. A new species of *Syphacia,* characterized by the presence of a single mamelon on the male, was collected from *Eutamias d. dorsalis* (Baird, 1855) Merriam, 1897. In addition, *Syphacia peromysci* Harkema, 1936 was collected from *Peromyscus maniculatus rufinus* (Merriam, 1890) Osgood, 1909; *S. eutamii* Tiner, 1948 from *E. d. dorsalis*; and *S. citelli* Tiner & Rausch, 1950 from *Citellus variegatus grammurus* (Say, 1823) Elliot, 1904.

A new species of *Gongylonema* was collected from *Peromyscus m. rufinus; P. boylii rowleyi* (Allen, 1893) Mearns, 1896; *P. t. truei* (Shufeldt, 1885) Thomas, 1894; and *Reithrodontomys m. megalotis* (Baird, 1858) Allen, 1893.

Rictularia coloradensis Hall, 1916 was collected from *E. d. dorsalis* and *P. m. rufinus.*

66. ***Platynosomum fastosum* in an Illinois Cat.** NORMAN D. LEVINE AND PAUL D. BEAMER, University of Illinois, Urbana.

In March, 1957 a 3-year-old male cat was submitted to the University of Illinois Veterinary Clinic. A diagnosis of chronic nephritis and chronic eczema was made by Dr. Dragutin Maksic, and euthanasia was performed. At necropsy (performed by Dr. Paul S. Quinn) advanced hydronephrosis of the right kidney and enlargement and some degeneration of the left kidney were found. The liver was markedly congested. On histopathologic examination diffuse congestion, subacute periportal hepatitis, bile duct proliferation and an occasional focus of parenchymal necrosis were found. Over 150 *Platynosomum fastosum* were collected from the bile ducts throughout the liver. This fluke has been reported from Malaya, British Guiana, Brazil and Puerto Rico, but has apparently not been reported heretofore from continental North America. According to the owner, the cat had lived in Miami, Florida and New

Orleans, Louisiana almost all its life. While in Miami, it had been accustomed to wander, and it probably became infected there.

67. **A Progenetic Lecithodendriid Trematode from a Calopterygid Damselfly Naiad.** J. E. HALL, Purdue University.

During the summer of 1956 a progenetic trematode species was found in all of 8 *Hetaerina americana* naiads from the lower Tippecanoe River, Indiana. The parasites occurred free in the body cavity in numbers ranging from 1 to 6 per insect, and the majority of the worms were fully developed adults containing numerous eggs. The short ceca, V-shaped excretory bladder, false cirrus sac, median and preacetabular position of the genital pore, and obscure body spination place the species in the subfamily Lecithodendriinae. It is closest to *Prosthodendrium*, but differs from that genus by having a conspicuous accessory papilla anterior to the genital pore and gonads in a more posterior location.

68. **Studies on the Biological Control of Schistosome-bearing Snails: The General Histology and Topographic Microanatomy of** *Australorbis glabratus*. CHIA-TUNG PAN, Harvard School of Public Health, Boston, Massachusetts.

Despite the fact that the parasitic trematodes of man utilize at least one fresh-water molluscan intermediate host, we have not discovered a comprehensive study of the histology of a single important molluscan host. In connection with studies on the biological control of schistosomiases, a histological study of *Australorbis glabratus* has been carried out as a necessary requisite for subsequent histopathological investigations on this snail. The results are presented as a systematic description of 9 organ systems or tissues; (I) epithelium, (II) connective tissue, (III) muscular tissue, (IV) nervous system and sensory organs, (V) circulatory system, (VI) respiratory system, (VII) renal organ, (VIII) alimentary system, and (IX) reproductive system. The epidermal tissue consists of essentially simple epithelium. The fibroblasts in the connective tissue appear to be a very important cellular element owing to their ability to transform into the amoebocyte and to repair damaged tissues. Three types of muscular fibers, the granular, the intermediate granular, and the smooth fibers, are present. The ganglion cells are arranged peripherally, and the nerve fibers centrally, in each ganglion. The heart is provided with 2 valves, an atrioventricular and an aortic. A lymphoid tissue is described for the first time in pulmonate snails. This tissue is regarded as a normal site of amoebocyte-formation. The respiratory surface is covered with 4 types of epithelial cells. The kidney consists of 2 histologically and anatomically distinct portions. Three digestive glands pour their secretions into a single digestive tract which can be subdivided into 7 anatomically and histologically distinct sections. The male and female germinal cells develop side by side in the ovotestis.

69. **Schistosomiasis in Japan.** KOYO OKABE, Kurume University, Japan.

The Kofu basin is the largest of the 5 endemic areas of schistosomiasis japonica in Japan. It contains about 90 square kilometers and has a population of about 330,000. The smallest area, the Katayama district, covers only 9 square kilometers and has a population of about 38,000. The Tone River focus is an unusual one because the snail colonies are confined to the swampy areas within the dikes of the river. Studies of 1 colony in this area indicate that floods have a marked effect on the population density.

The effect of lining irrigation ditches with concrete, on the colonies of *Oncomelania nosophora*, has been noted in 1 small isolated area near Kurume (Komorino-machi). All ditches were lined within the period of 1950 to 1954. Periodic surveys since then have failed to reveal snails. In the Katayama district 40% of the ditches have been lined; this resulted in a marked reduction in the snail population and the size of the endemic area. The incidence of the infection also has been reduced but in 1955 3% of the inhabitants were infected. It has been calculated that a total of 3,420 kilometers of ditches in Japan should be lined.

Snails were collected from an area (Nagatoishi) where sodium pentachlorophenate had been applied twice a year for 7 years. In the laboratory the LD_{50} for these snails was compared with snails collected in an area where the molluscicide had never been used. The former were much more resistant.

70. **Studies on the Cercariae of the Mountain Lake Region.** FRANK J. ETGES, University of Cincinnati.

In connection with attempts to secure information on the life histories of certain trematodes of bats, a survey of the snails in the vicinity of the University of Virginia Biological Station at Mountain Lake, Virginia has been made. Aside from several common species of

cercariae (i.e. *Echinostoma* and *Notocotylus*), a number of species have been studied, some of which are probably undescribed. The following snail genera have been examined most intensively: *Physella, Helisoma, Nitocris, Goniobasis, Lymnaea,* and *Gyraulus.* Cercariae of the following types have been observed: microcotylocercous, microcercous, macrocercous, xiphidiocercariae, virgulate cercariae, and furcocercous cercariae. Collections and study will continue through the summer. Studies concerning the life histories of some of these cercariae are in progress, and any further information on them will be reported.

(The present work is being carried on with the aid of a National Science Foundation Grant, made through the University of Virginia.)

71. **Further Uses of a Planetary-Type Mixing Machine Adapted for Separating Worm Eggs from Feces.** CHARLES H. HILL AND RALPH E. ZIMMERMAN, Animal Disease and Parasite Research Division, Agricultural Research Service, USDA, Beltsville, Maryland.

The planetary-type mixing machine described by Hill and Zimmerman (1954, J. Parasitol. **40** (Suppl.): 32), and used by them for separating whipworm eggs from swine feces, has been improved by increasing the width of the top and bottom brass rings of the cylindrical screen basket into which the feces are put to one-half and one inch, respectively, and by hinging the motor housing so that the basket can be more conveniently removed for cleaning and refilling with fecal material. Four hundred to 500 ml of feces can be processed at 1 time, the volume being determined by the fiber content. The time consumed in screening one batch of feces (about 5 minutes) has been further reduced by the introduction of the water used to flush the eggs from the feces directly into the basket during the operation instead of into the vessel surrounding the basket before starting the screening process. This machine has been used successfully for the separation of the eggs of *Ascaris lumbricoides, Hyostrongylus rubidus, Oesophagostomum* spp., and *Metastrongylus* spp. from the feces of hogs, *Haemonchus contortus* and *Trichostrongylus colubriformis* from the feces of sheep, and *Ancylostoma caninum* from the feces of dogs. Between 99 and 100% of the eggs present in the specimens were recovered as determined by egg counts made before and after processing.

72. **A Field Thermistor Thermometer for Microhabitat Temperature Studies.** C. W. MCNEIL AND W. M. WALTER, State College of Washington.

(No abstract submitted.)

73. **Sex Determination and Oviposition Rate in the Snake Mite, *Ophionyssus natricis* (Gervais) (Mesostigmata: Dermanyssidae).** JOSEPH H. CAMIN AND PAUL R. EHRLICH, The Chicago Academy of Sciences.

Although the parthenogenetic production of males has been demonstrated in the snake mite (Camin, 1953) the ratio and order of production of male and female offspring by fecundated females has not been fully understood. Experiments have been conducted to elucidate these facts and to determine the effects of the frequency of feeding and amount of blood ingested on the oviposition rate and total number of eggs produced. The equipment and methods devised and the results obtained will be demonstrated. (This investigation was supported by research grant E-1039(R) from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health.)

74. ***Trichobilharzia alaskensis*, a New Species of Avian Schistosome from Alaska.** REINARD HARKEMA, N. C. State College, STURGIS MCKEEVER, University of California at Davis, DAVID A. BECKER, University of Nebraska.

Apharyngeal, furcocercous, dermatitis-producing cercariae liberated from *Lymnaea stagnalis* were used in infection experiments with Pekin ducklings. Adult schistosomes were recovered in from 10 to 17 days. It appears that these specimens constitute a new species of *Trichobilharzia* with close affinities to *T. ocellata, T. elvae* and *T. szidati.* Testes of *T. ocellata* are almost twice the size of those of *T. alaskensis.* Anterior body width of *T. kossarewi* (*ocellata*) is much greater than that of *alaskensis.* Posterior end of *T. alaskensis* broadens while *T. ocellata* apparently does not. *T. alaskensis* (male) differs from *T. elvae* and *T. szidati* in several respects: cecal reunion is at level of anterior third of seminal vesicle, while in latter two species reunion is either at anterior end of seminal vesicle or anterior to it; seminal vesicle is much larger than that of *T. elvae* or of *T. szidati.* Gynecophoric canal of *T. alaskensis* is much smaller than that of *T. szidati* and farther from acetabulum than in *T. szidati.* Cecal reunion in female *T. alaskensis* is at level of anterior third of ovary; in *T. elvae* immediately posterior to seminal receptacle; in *T. szidati* at anterior end of this organ. Distance from anterior end to acetabulum is greater in *T. alaskensis* than in *T. szidati.* Cer-

cariae of *T. alaskensis* are larger than those of *T. elvae* and the behavior patterns differ. *T. szidati* cercariae are smaller than those of *T. alaskensis*.

75. **Larval Trematodes of the Columbia Basin, Washington.** A. DEFOREST, State College of Washington.

During the period from April 1956 through April 1957, 2236 *Stagnicola palustris nuttalliana* (Lea, 1841) and 1330 *Physa propinqua* Tryon, 1865, were collected and examined. Of these, 885 *S. palustris nuttalliana* and 102 *P. propinqua* were infected with larval trematodes. Nine groups of cercariae were isolated, these being: monostome, leptocercous, echinostome, xiphidiocercariae, pleurolophocercous, apharyngeal brevifurcate distome furcocercous, and pharyngeal longifurcate distome furcocercous cercariae. An encysted metacercaria was the most common form encountered. Snails collected from seep ponds and lakes had the highest incidence of infection, while snails from the irrigation canals had the lowest. (This investigation was supported in part by research grant E-900 from the National Institutes of Health, Public Health Service, and in part by funds provided for biological and medical research by the State of Washington Initiative Number 171.)

76. **Some Trematodes from Sapelo Island and Adjacent Mainland.** ELON E. BYRD, MARY C. DUNN, AND HELEN F. JORDAN, University of Georgia.

(No abstract.)

77. **Notes on *Spirorchis haematobium* (Stunkard, 1922) (Trematoda: Spirorchiidae) in the Definitive Host.** M. J. ULMER, Iowa State College.

Spirorchis haematobium (Stunkard, 1922) occurs rather frequently in painted turtles (*Chrysemys picta belli*) and snapping turtles (*Chelydra serpentina*) in lakes near the Iowa Lakeside Laboratory in northwestern Iowa. During the summers of 1955–1957, of 67 turtles which were carefully dissected, 9 were found infected with this trematode. Of 55 painted turtles examined, 7 harbored the fluke in the esophageal region or within mesenteric vessels. Of the 12 snapping turtles examined, 2 were infected, the flukes occurring here either within the ventricle of the heart or within blood vessels of the intestines. The parasite, when present in painted turtles, was found only occasionally within mesenteric vessels but far more frequently in the esophageal region where it apparently occurs outside the vascular system. Serial sections of worms *in situ* in the esophagus of painted turtles indicate that in many instances the adult worms have left the vessels and have wandered through the submucosa, causing extensive tissue damage. The presence of adult flukes of the family Spirorchiidae in sites other than the vascular system is of interest, since previous reports of this parasite and of related species describe the members of the family as parasites of the blood stream of turtles. (This investigation was supported in part by a grant from the National Science Foundation.)

78. **The Homologies of the Clamp Sclerites of *Hexostoma*, (Hexostomatidae: Diclidophoroidea).** WILLIAM J. HARGIS, JR., Virginia Fisheries Laboratory, Gloucester Point, Virginia.

The comparative anatomy of the clamps of various diclidophoroidid parasites (Monogenea: Trematoda) has been considered by several authors. Sproston (1945, Parasitology **36:** 191–194) suggested that the sclerites of the frameworks of these holdfasts are homologous. Of *Hexostoma*, an aberrant genus, she stated, "In *Hexostoma* it appears that the end-point has been reached both in development of the sucker (= sucker-type clamp, *mihi*) and in the reduction of the sclerites . . . the sclerites have fused on either side and in the middle into highly irregular pieces . . . The homology here is, of course, highly suppositious . . . " Several workers have studied hexostomids in detail since Sproston, but none has added information concerning the homologies of the clamp sclerites. (See Millemann, 1956 J. Parasitol. **42:** 316–319) While examining several specimens of *Hexostoma* sp. from the False Albacore, *Euthynnus alleteratus* from Chesapeake Bay, I noted that the small laterally projecting elements on the medial and lateral clamp sclerites were actually separate from the main body of the sclerite and not fused as in the descriptions of earlier workers. These small elements appear to be homologues of the basal ends of the opposable middle loop of the clamps of other diclidophoroidids. That portion of each medial and lateral sclerite which is anterior to this small element probably represents the ventral or anterior loop while the posterior portion represents the dorsal or posterior loop elements of more typical diclidophoroidids. If the preceding is true, then the middle X-shaped clamp sclerite is obviously homologous to the center piece or "spring" of related monogeneids.

79. **Some Observations on the Life Cycle of *Strigea elegans*, Chandler and Rausch, 1947 (Trematoda: Strigeidae).** J. C. PEARSON, School of Veterinary Science, University of Queensland.

Adults and eggs of *S. elegans* were collected from a snowy owl, *Nyctea nyctea*, from southern Ontario. Eggs remained viable, and their miracidia infective, for 11 months in tap water at about 8° C in the dark. The snails *Gyraulis parvus, Planorbula armigera, Helisoma trivolvis*, and *H. antrosa* were exposed to miracidia. Cercaria-producing infections developed only in *Gyraulus parvus*, cercariae first emerging 26 days after exposure. Cercariae are typical of strigeids, with 4 pairs of postacetabular penetration glands, and a flame cell formula of $2[(1+1)+(1+1+(1))]=10$, with no commissure between the bladder arms. Cercariae escaped from daughter sporocysts in the peri-hepatic haemocoele, travelled along the perirectal blood sinus to the collar, and emerged through fixed "escape pores" in the same manner as cercariae of *Alaria arisaemoides* and *A. canis*. Cercariae penetrated tadpoles of toad (*Bufo americanus*), wood frog (*Rana sylvatica*), and green frog (*Rana clamitans*) where they developed in about 2 weeks into mesocercariae which lay free in the tail and subcutaneously over the belly. During metamorphosis of the tadpole, mesocercariae moved into the hind limbs. Mesocercariae resemble cercarial bodies, but have the flame cell formula $2[\{(3+3+3)+(3+3+3)\}+\{(3+3+3)+(3+3+3)\}]=72$, with a post-acetabular commissure between the bladder arms. Mesocercariae were fed to a garter snake (*Thamnophis sirtalis*) and 3 domestic ducklings (*Anas boschas*); in these hosts mesocercariae underwent metamorphosis into encysted, encapsulated tetracotyles in the tissues. Mesocercariae were also fed to 2 immature great horned owls (*Bubo virginianus*), a natural definitive host of *S. elegans*. No eggs of *S. elegans* appeared in the feces of either owl, and at autopsy 21 and 113 days later no adults were found in the intestine, but tetracotyles were found subcutaneously. It appears from this that *S. elegans* may have a 4-host life cycle.

80. **The Histopathology of the "Tumor" on the Brain of the Stickleback caused by *Diplostomum baeri eucaliae* Hoffman and Hundley, 1957.** G. L. HOFFMAN AND J. B. HOYME, University of North Dakota.

The structure of this "tumor" has been reported as an out-pocketing of the dura of the brain with a substantial amount of metaplastic or hyperplastic columnar epithelium surrounding the worms (Hoffman and Hundley, 1957, J. Parasitol. **43:** in press). Further study has shown that the epithelium in the "tumor" is an outgrowth of the choroid plexus of the brain which surrounds the worms at the postero-lateral aspect of the optic lobes. (This investigation was supported in part by research grant B-855 from the National Institutes of Health, Public Health Service.)

81. **Preliminary Observations on the Oviposition and Hatching of Eggs of Aedine Mosquitoes.** A. RALPH BARR, Department of Entomology, University of Kansas, Lawrence, Kansas.

A method is described for the collection of eggs from individual females. Techniques are described for the handling of such eggs so that they may be induced to hatch at will. The effectiveness of several agents which promote hatching is discussed. Preliminary observations are given on the hatchability of the eggs of univoltine *Aedes*.

82. **Some Aspects of the Biology of *Cuterebra angustifrons* Dalmat 1942 (Cuterebridae: Diptera).** E. I. SILLMAN, Ontario Agricultural College.

Cuterebra angustifrons is a warble fly infesting, in its larval stages, the white-footed mouse, *Peromyscus leucopus noveboracensis*, throughout eastern North America, other species of *Peromyscus*, and *Rattus norvegicus, R. rattus, Eutamias* spp., and *Mus musculus*. Thirty-five (28%) of 125 *P. leucopus*, live-trapped from 4 areas in Southern Ontario in 1955, were found to be infested with second- and third-instar larvae. These and 5 additional areas in 1956 yielded 41 (14%) infested of 288 live-trapped *P. leucopus*. Infested mice were maintained in the laboratory and the course of infestation followed. Forty-eight puparia were arranged in 3 temperature groups, and data on duration of pupal period and percentage and pattern of emergence of adults were obtained. Though the groups were not equal in number, and numbers of puparia were small, the following conclusions seem to be warranted: (a) the long pupal period, whatever the temperature to which pupae were subjected, and the restricted period within which flies emerged from puparia shifted abruptly from 7° C to room temperature, suggest diapause in the pupal stage; (b) a period of exposure to cold temperatures favors emergence of a greater percentage of adults; and (c) duration of the pupal period averaged 315 days under tempera-

ture conditions approximating those in nature. Attempts to mate adults in the laboratory were unsuccessful. The seasonal incidence of second- and third-instar larvae in live-trapped mice was observed and compared for 1955 and 1956.

83. **Host-parasite Relations of the Screw-worm.** JACK H. ESSLINGER, The Rice Institute.

Studies have been made on the relation of the screw-worm to the bacillus (*Proteus chandleri*) consistently found with it. The hypothesis that this represents a symbiosis has been discarded in view of the abilty of the larvae to develop both *in vivo* and *in vitro* in the absence of the bacterium.

Experiments with re-infestations in guinea pigs have shown that the increased tolerance developed by the hosts is not manifested by any marked reduction in the intensity of the clinical picture.

Investigations have been made into the toxic and immunogenic properties of the secretions and excretions of the screw-worm, employing both *in vitro* and *in vivo* methods of aseptic cultivation of the larvae.

84. **Feeding Behavior of the Snake Mite, *Ophionyssus natricis* (Gervais) and Other Dermanyssidae (Acarina: Mesostigmata).** JOSEPH H. CAMIN AND PAUL R. EHRLICH, The Chicago Academy of Sciences.

A series of experiments have been carried out in order to determine the factors inducing feeding in these mites both on the host and *in vitro*. Attempts have been made through surgical and other means to isolate the special sense organs which are involved in initiating the feeding responses. The results obtained in these experiments will be discussed. (This investigation was supported by research grant E-1039(R) from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health.)

85. **Observations on the Acarine Family Speleognathidae Including Two Previously Unreported forms in Native Game Birds.** G. M. CLARK, Patuxent Research Refuge, Laurel, Maryland.

The family Speleognathidae Womersley, 1936 (Acarina, Trombidiformes) now contains 29 species in 4 genera, most of which have been described since 1954. These mites are apparently strict endoparasites and have been recovered from amphibians, various mammals, and many birds. Two species have been reported from the United States, 3 from Australia and the rest from the Belgian Congo. In addition, we have found species in both the lesser scaup duck, *Aythya affinis* (Eyton, 1838), from the upper Mississippi and the eastern bobwhite quail, *Colinus virginianus virginianus* (Linnaeus, 1758), from the Patuxent Research Refuge.

Certain features of the morphology of these mites, particularly setation and cuticular structure, enable them to move rapidly over the surface of heavy nasal mucus. Although usually found in the nasal fossae, they are often recovered from other areas of the respiratory system. There is some indication that certain species prefer specific locations within the nasal fossae. No extreme host reactions to these mites have been noted. The feeding habits of certain species are under investigation.

The life cycle can be completed entirely within the host and consists of larval, nymphal and adult stages. The method of dispersion is not well understood, but there are indications that certain species are spread from parent bird to nestling in the feeding process.

86. **Food Habits of Laelaptid Mites in Relation to Pathogen Vector Potentials.** DEANE P. FURMAN, Department of Entomology and Parasitology, University of California, Berkeley.

In assessing the potential role of an arthropod as a vector of pathogens occurring in the blood stream of its presumed host, it is almost axiomatic that failure to penetrate the intact skin of the host relegates the arthropod to a role of minimal or no significance as a vector. The ability to penetrate intact skin of vertebrate hosts has been demonstrated for relatively few laelaptid mites.

In the present work specimens of *Haemogamasus ambulans* (Thorell), obtained from nests of *Neotoma fuscipes*, the dusky footed wood rat, have been cultured in glass tubes in the laboratory. The mites feed readily on heparinized mouse blood supplied as free drops or on cotton; however, attempts to feed them directly on rodent hosts have been unsuccessful. It was noted that wood rat nests frequenly contained many small arthropods such as collembolans and psocids. When these were introduced to tubes containing *H. ambulans* the mites seized them and sucked out the body fluids promptly. Anoplura from *Neotoma* were similarly used as food by the mites.

This type of feeding may well prove to be common among some of the other species and genera of laelaptids presumed to be parasitic, but actually primarily predacious, and stands in marked contrast to the situation presented by such dermanyssid genera as *Ornithonyssus* and *Dermanyssus*, which appear to contain only obligatory, blood-sucking parasites.

87. **Observations on *Micromegistus bakeri* Trägårdh, 1948, (Acarina: Mesostigmata: Parantennulidae) an Antennophoroid Mite Occurring on *Scarites* Beetles.** DONALD E. JOHNSTON, GARY E. JOHNSTON AND DOMINIC L. DEGUISTI, Department of Biology, Wayne State University.

Micromegistus bakeri is a small trigynaspid mite which lives in phoretic or commensal association with the carabid beetle *Scarites subterraneus* (Fab.). The host is common in backyard, garden and vacant lot habitats in southern Ontario and Michigan. All active stages of *M. bakeri*, larvae, protonymphs, deutonymphs (all previously undescribed) and adults, occur on the beetle. The mites are not found in any particular body region but move freely over the surface of the host.

Feeding in *M. bakeri* was observed in one instance. A *Scarites* in a collecting vial regurgitated a brownish fluid which was smeared on the vial wall. Several *Micromegistus* approached the droplet, sampled it with their chelicerae and then rapidly and continuously inserted and withdrew the chelicerae for periods ranging from 30 seconds to 2 minutes. While it seems unlikely that *Micromegistus* solicits the host to obtain food (as do the myrmecophilous *Antennophorus*) the above feeding observation and the slender edentate chelicerae of these mites probably indicate that they are in some way dependent on the host for food rather than being predacious. *Scarites* is a predator and possibly the mites feed on spilled body fluid of the beetle's prey.

Micromegistus bakeri Trägårdh, 1948, is possibly a synonym of *Micromegistus viduus* (Berlese, 1888) *comb. nov.* which was described from a single male from a *Scarites* collected in Paraguay.

88. **The Cercarial Type in the Genus *Allocreadium*.** L. E. PETERS, Purdue University and University of Michigan Biological Station.

Since the writer reported the retention of a well developed stylet in mature progenetic adults of *Allocreadium neotenicum* from water beetles (1957, J. Parasitol. **43**: 136–142), a complete stylet has also been found in mature specimens of *A. lobatum* from *Semotilus atromaculatus* in both Michigan and Indiana. In *A. ictaluri*, search for a stylet showed it to be absent in adults and most metacercariae, but stylets were found in very young cysts in unionid mussels, which are known to be the second intermediate hosts of *A. ictaluri*. Although not yet proved experimentally to be the young metacercariae of *A. ictaluri*, the cysts with stylets are among the smallest in a continuous series leading to metacercariae which unquestionably are immature *A. ictaluri*, as demonstrated by Seitner (1951, J. Parasitol. **37**: 223–244). Unlike *A. neotenicum* and *A. lobatum*, *A. ictaluri* sheds the stylet, which was found in various stages of disintegration in the cyst. The discrepancy as to the type of cercaria in the genus *Allocreadium* reported in previous studies thus seems to be resolved by establishing the larval type as an ophthalmoxiphidiocercaria.

89. **Comparative Morphology of Miracidia in the Gorgoderidae.** DONALD WOOTTON AND LEWIS PETERS, University of Michigan Biological Station, Woods Hole Marine Biological Laboratory, and Purdue University.

Silver-impregnated miracidia of *Gorgoderina attenuata*, *Phyllodistomum superbum*, *P. staffordi*, and *P. undulans* all have 15 epidermal cells in 3 tiers, expressed by the formula 6-6-3. Two variations in *P. undulans* are 5-6-3 and 6-5-3; also, 1 specimen of *P. superbum* contains 5 cells at the anterior end and 8 additional ones not arranged in recognizable tiers. Three kinds of pores are present: 4 groups of 3 or more pores on the terebratorium; 2 excretory pores, usually located between the second and third tiers; and 2 small pores at the posterior tip, evidently associated with a pair of bristles. End view examination shows that all 3 kinds of pores are in bilateral symmetry; allowing for slight torsion on fixation, and considering the 2 excretory pores to be ventro-lateral, the terebratorium bears a ventro-lateral and a dorso-lateral group of pores on each side, and the 2 small posterior pores are laterally placed. Among the gorgoderid species included in this study, no consistent differences have been observed either in the epidermal cell pattern or in the number and location of pores.

90. **Brown and White Pelicans as Hosts for Schistosomes of the Genus *Gigantobilharzia*.** W. HENRY LEIGH, The University of Miami.

Three sick and dying white pelicans and 1 brown pelican from the Everglades region of South Florida were found to be heavily infected with a schistosome of the genus *Gigantobilharzia*. This genus has not been reported previously from pelicans.

The slender worms, with subterminal mouth and striated cuticula, are 7 to 11 mm in length and occur in scattered egg-darkened patches in the veins of the intestinal wall, sometimes extending into the submucosa. Male worms possess a short gynaecophoric canal, with projecting cirrus, lack oral and ventral suckers, and have testes numbering 87 to 150 distributed from the area posterior to the gynaecophoric canal to the posterior end. Female worms also lack oral and ventral suckers, have only a single egg in the uterus at a time, and the genital pore opens near and posterior to the mouth opening. The eggs are oval and unspined although some possess a terminal rudimentary knob. Embryonated eggs average 0.090 mm in length by 0.054 mm in width. Eggs in all stages of development are present in the mucosa and mature ones hatch quickly in saline. Eggs apparently do not often reach the hepatic portal vein, since they were not found in the liver.

These worms resemble *Gigantobilharzia huttoni* (Leigh, 1953) which has been experimentally reared in parakeets from dermatitis-producing cercariae of the marine snail *Haminoea antillarum guadalupensis* from South Florida. The differences noted could be due to host differences. Life-history studies are planned to clear up the specific identity of this schistosome from the pelican. (Supported in part by Research Grant RG4051C from the Division of Research Grants of the National Institutes of Health, Public Health Service.)

91. **The Life-History of a New Trematode of the Genus *Paramacroderoides* in the Florida Spotted Gar.** W. HENRY LEIGH, The University of Miami.

After working out the life-history of *Paramacroderoides echinus* Venard, 1941, it was discovered that the trematodes recovered from the intestine of *Lepisosteus platyrhincus* in Florida represented a mixture of 2 similar yet distinct species differing in number and size of oral spines and in body size attained at the time of sexual maturity. It had been noted earlier that an occasional naturally infected snail, *Helisoma duryi*, produced cercariae similar to those of the forms regarded as *P. echinus* but lacked the orange pigment in the oil-like droplets associated with cercariae observed in laboratory-induced infections.

Later study of the colorless cercaria revealed that it was the larval stage of the larger of 2 species of the genus *Paramacroderoides* whose major distinguishing characteristics were number and size of oral spines and size ratio of oral to ventral suckers. The two species of cercariae differed in behavior and structure. The orange cercaria was smaller and possessed a fin fold on the tail which the other lacked. There were differences in the positions of penetration glands, although each species had 4 glands on one side and 5 on the other. There were clearly recognizable differences in the floating attitudes of the two cercariae, and the larger cercaria produced a much larger metacercaria in the fish intermediate host, *Gambusia affinis holbrookii*.

It is now apparent that the larger of the two Florida species is *P. echinus* Venard, while the smaller is an undescribed species with only 3 to 5 small spines in the first incomplete row as compared with 15 to 17 large spines in the same row for *P. echinus*. At present these two species are the only ones recognized for the genus. (Supported in part by Research Grant RG4051C from the Division of Research Grants of the National Institutes of Health, Public Health Service.)

92. **Digenetic Trematodes in Louisiana Fresh-Water Fishes.** G. C. MILLER AND H. J. BENNETT, Louisana State University.

The parasitic fauna in Louisiana freshwater fishes is practically unknown. This fact has presented a number of interesting research problems. Present attempts are being made to present a rather comprehensive treatment of the biology and ecology of the parasites in Louisiana fishes. This report deals exclusively with the digenetic trematodes. In total, 629 fishes representing 14 families, 20 genera, and 31 species have been collected and examined. Most, but not all, were game fishes which were collected from 26 localities throughout the state. Nineteen species of digenetic trematodes, representing 11 families and 17 genera have been identified and studied. One of these is apparently a new species belonging to the genus, *Phyllodistomum* (Gorgoderidae). Studies on the 19 species have revealed new information regarding their morphology, taxonomy, ecology and distribution. Sixteen of the 19 species studied are recorded as new to Louisiana. The digenetic trematodes were the most commonly encountered parasites in Louisiana freshwater fishes. This included both the number of species and the number of individuals. Of the 629 fishes examined, 386 or 61.3% were infected with some species of digenetic trematode.

93. **Dicyemid Mesozoans from the Gulf of Mexico.** ROBERT B. SHORT, Florida State University.

From November, 1954 to April, 1957, 17 octopuses (12 *Octopus vulgaris*, 5 *O. joubini*) from the northern Gulf coast of Florida have been examined for dicyemid mesozoans. All specimens of *O. vulgaris* and 3 of the *O. joubini* were infected. *Dicyema aegira* McConnaughey and Kritzler, 1952 was present in all *O. vulgaris* (Dr. B. H. McConnaughey kindly confirmed identification of this species). Two of the 3 infected *O. joubini* also harbored *D. aegira*, and, in addition, all 3 were parasitized by an apparently different species which seems to be undescribed.

The present abstract appears to be the first published record of dicyemid mesozoans from the Gulf of Mexico. A more complete taxonomic report will be published elsewhere.

94. **The Concept of Vector Efficiency in Experimental Studies of Plague.** LEO KARTMAN, San Francisco Field Station, Communicable Disease Center, Public Health Service, San Francisco, California.

The prevalent concept of vector efficiency is based primarily upon laboratory experiments which give, in a somewhat artificial manner, the potentialities for plague-transmission by individual fleas of a given species. The need is for an efficiency index in which laboratory and field data are combined to derive a valuation which is closer to the actual vector efficiency under natural conditions. A model for the determination of plague vector potential is proposed in which factors governing plague-transmission by fleas under laboratory conditions are related to: 1) the percentage of plague infection in individual fleas or in flea pools taken from rodents and/or rodent nests, and 2) the mean number of fleas per species per rodent and/or rodent nests. Thus the plague vector potential is reflected by an index relating 3 components in the following manner: (experimental vector index) × (field infection index) × (field prevalence index) × 100. The components used to derive each index are given and the problem is discussed both historically and from the standpoint of current practice.

95. **Studies on the Biology of the Lone Star Tick, *Amblyomma americanum* (L.), at Camp Bullis, Texas.** GEORGE W. HUNTER, III, JAMES V. GRIFFO, J. W. WILLIAMS, AND F. M. PHILIPS, University of Florida and the Fourth Army Area Medical Laboratory, Ft. Sam Houston, Texas.

In 1952 a study was undertaken of the biology and control of the lone star tick, *Amblyomma americanun* (L.), in the Camp Bullis, Texas area in order to supplement the studies made under laboratory conditions by Sacktor, Hutchinson and Granett (1948). A summary of some points follows: (1) 24 of 31 engorged ticks migrated for 10–15 days before burrowing into loose soil (rather than merely under decayed vegetation) before laying eggs; (2) eggs were deposited for a period of from 6–22 (av. 14.4) days and the ticks laid an average of 2270 eggs per tick; (3) 6 egg masses took 34–39 days to incubate and hatched 70–250 larvae at the end of this period, with temperatures ranging from 22–34° C; (4) marked nymphs and adult ticks were found to migrate as much as 20 feet to human bait; (5) marked ticks recovered from same area 2 and 4 months later suggest little summer migration; (6) larval, nymphal and adult counts made on the same quadrats over 3 years show marked variation in numbers of ticks recovered with ticks on the ground practically disappearing during the winter months; (7) deer examined immediately after being shot during November–December at Camp Bullis yielded 0–51 adults; (8) the above findings were correlated where feasible with temperature and humidity records.

96. **Investigations on the Cultivation of *Toxoplasma gondii* in Tissue Cultures.** M. KATHERINE COOK AND LEON JACOBS, Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Maryland.

In addition to the types of cells already reported by others to support *in vitro* growth of *Toxoplasma*, a number of cultures prepared from tissues of rodent, monkey, and human origin have been found suitable. Also, 12 "standard" cell lines have been shown susceptible. With a standard inoculum of 200,000 toxoplasmas, the lysis time of these cultures varied from 5 to 8 days except for human conjunctiva (Chang) and human intestine (Henle). In these 2 cultures, fibroblast-like cells persisted after destruction of the epithelium-like cells although they were found to be infected with the parasite.

Large numbers of parasites enter cells within one-half hour after inoculation of cultures. However, in cultures of cells from a single organ (monkey kidney) it appeared that some cells were resistant to infection. Observations of infected cultures indicated that active invasion of cells by the parasite did not result in prompt death of the cells. Host cell age had no effect

on proliferation of parasites, but there was a direct relation between temperature of incubation and lysis time. Colchicine-arrested cultures of monkey kidney were able to support growth of *Toxoplasma* as well as did non-arrested cultures, and harbored more parasites per cell. Prolonged serial passage of *Toxoplasma* in tissue culture did not result in an increase in virulence for mice or hamsters.

97. **Staining of *Toxoplasma gondii* in Frozen Sections Using Fluorescein-Labelled Antibody.** R. K. CARVER AND MORRIS GOLDMAN (With the technical assistance of JEAN HUEY), Communicable Disease Center.

Using a modification of the technique described by Bush and Hewitt (1952), sections 10 microns thick were cut from unfixed frozen tissues obtained from mice infected with *T. gondii*. Fluorescein-labelled specific antiserum was absorbed with pig liver powder and used to stain the organisms in the sections. In addition to the bright staining of morphologically recognizable organisms, specifically stained areas were seen in which organisms could not be identified. Such areas presumably represent concentrations of soluble antigen released from the toxoplasmas.

98. **Immunity to Toxoplasmosis in the Newborn Rat.** E. K. MARKELL AND W. P. LEWIS, University of California, Los Angeles.

Transplacental and translacteal acquisition of immunity against toxoplasmosis was measured in baby rats by the method of exchanging litters so that animals born to normal mothers might be nursed by immune mothers, and the reverse. Four groups were thus established: a) normal mothers nursing infant rats born to normal mothers, b) normal mothers nursing infant rats born to immune mothers, c) immune mothers nursing infant rats born to normal mothers, d) immune mothers nursing infant rats born to immune mothers. Groups were comparable in age and size. The baby rats were challenged a few days after birth by the intraperitoneal injection of a dose of *Toxoplasma* organisms previously determined to be lethal for normal rats of that age. Two separate experiments, set up in the same manner and involving a total of 142 baby rats, were performed with strikingly similar results. The combined mortality rate in rats born to normal mothers and nursed by normal mothers (controls) was 96%, whereas that in rats born to normal mothers and nursed by infected mothers was under 3%. The groups born to infected mothers showed an increased survival over the controls, but intermediate between those and the group with lowest mortality. Dye test antibody titers were obtained on both milk and serum of some of the mother rats. While the normal rats were not found to have antibodies detectable by this test, both serum and milk of the immune animals possessed these antibodies.

99. **Studies on the Resistance of Pseudocysts of *Toxoplasma gondii*.** LEON JACOBS AND MARJORIE L. MELTON, Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Maryland.

Infection *per os* with *Toxoplasma* is accomplished more readily in mice fed tissues from chronically infected animals than from animals with acute infection. This is interpreted as representing the difference in stage of the parasite found in acute and chronic infections. The proliferative form of the parasite has already been shown to be very short-lived outside viable host cells. In the present study, the survival of encysted parasites during storage, digestion, drying, and heating was measured.

Brains of rats with chronic infections with RH strain *Toxoplasma* served as the source of cysts. The infectivity of each brain was checked by inoculation of a suspension of part of it into mice immediately after killing the donor animal. Infectivity of intact brain substance was still demonstrable after 6 weeks' storage in broth at 4° C, although there was a drop in titer. Infectivity of suspensions of rat brain stored at 4° C was demonstrable for 24 days, the longest period of storage tested. Following drying for 1 day, infectivity was lost. Parasites in macerated brain survived digestion for 3 hours in pepsin-HCl solution; there was some loss in infectivity at 3 hours, and the digest was non-infective after 4 hours. The critical temperature for encysted parasites appeared to be about 45° C; in 2 of 3 tests rat brains held at this temperature for 1 hour were no longer infective. 56° C for 30 minutes was lethal. All infectivity was lost following gradual elevation of temperature from about 25° C to 60° C, during a period of 20 minutes.

100. **A Procedure for Testing Meat Samples for *Toxoplasma*, with Preliminary Results of a Survey of Pork and Beef Samples.** LEON JACOBS AND MARJORIE L. MELTON, Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Maryland.

Previous studies have shown that *Toxoplasma gondii*, in its encysted form, can survive incubation in pepsin-HCl solutions for up to 3 hours. This suggested that a short digestion procedure would allow the detection of parasites in meat used for human consumption.

The technique developed is as follows: Samples of muscle up to ¼ pound in weight are ground in a meat grinder and mixed in a solution of pepsin, 1.3 g; NaCl, 2.5 g; concentrated HCl, 3.5 ml; H_2O to 500 ml. Digestion is allowed to proceed for 2 hours at 37° C; the suspension is agitated during digestion by means of a Magna-Mix apparatus. The digest is then filtered through cheese cloth and centrifuged at about 2000 rpm for 10 minutes. The supernatant fluid is discarded, and the sediment resuspended in saline and recentrifuged. The washed sediment is suspended in a small amount of saline, to make a total volume of 20 ml, and 1-ml aliquots are inoculated intraperitoneally into each of 10 mice. The remaining material is refrigerated, and on the next day the same mice are given a second injection.

Since it has been shown, in rats, that diaphragm muscle is found positive as frequently as other muscles, a survey was initiated using diaphragm from swine and beef slaughtered at a Baltimore abattoir. Results of this survey will be presented. Preliminary data indicate a prevalence of about 22% in the swine, 0% in beef.

101. **Changes in Virulence to Laboratory Mice of Newly Isolated Strains of** *Toxoplasma gondii*. Don E. Eyles, Nell Coleman, and Colvin L. Gibson, Laboratory of Tropical Diseases, National Institutes of Health, Memphis, Tennessee.

Strains of *Toxoplasma gondii* recovered from 6 different spontaneously infected hosts (man, cat, mouse, chicken, duck and pigeon) were observed through 20 or more passages in laboratory mice in order to study the manner in which the strains became adapted to growth in this host. In each case the strains, which were originally more or less avirulent, gradually became more virulent. After 20 passages most of them approached the degree of virulence of established laboratory strains.

In other experiments it was found that the use of cortisone may have accelerated the attainment of virulence, but the degree of virulence ultimately achieved was the same as that attained without its use. Similarly, the use at each passage of a 10× smaller inoculum did not slow the increase of virulence. Finally, observations were made upon the characteristics of substrains isolated from different organs of the same spontaneously infected host.

102. **Cultivation of** *Trichomonas vaginalis*, **Donné, 1837, in Association with Tissue Cultures.** Emil Kotcher and Alicia C. Hoogasian, University of Louisville, School of Medicine.

Hogue (1943) carried out experiments which led her to believe that *Trichomonas vaginalis* produced a substance which was toxic to tissue cultures from human fetal material and from chick embryos.

Our experiments were carried out with chick embryo explants and with HeLa and human synovial cells. *T. vaginalis* was cultured with these tissues. The tissues did not die as reported by Hogue. What tissue death did occur resulted from invasion of the tissues by the protozoan and appeared to occur as a result of mechanical injury rather than toxic products. *T. vaginalis* culture filtrates prepared with sintered-glass filters did not cause death of either chick embryo explants or of HeLa and human synovial cells. It is concluded that some factor or factors other than those resulting from *T. vaginalis* growth were responsible for the "toxic effects" reported by Hogue.

103. **Studies on the Physiology of** *Trichomonas hominis*. Joel M. Solomon, The Johns Hopkins University, School of Hygiene and Public Health. Baltimore, Maryland.

Trichomonas hominis is readily cultured axenically in the CPLM medium of Johnson (1943) but does not grow in the trypticase (STS) medium of Sprince (1947). Optimal growth is obtained at pH 6.5 to 7.0 at temperatures of 35° to 37° C. No growth occurs when the initial pH of the medium is 5.5 or less nor at temperatures below 27° C or above 41° C. At 41° C growth is rapid for 4 to 8 hours at which time it ceases. Death ensues rapidly without growth at 43° C. At an initial pH of 6.5, the generation time was 3.7 to 4.0 hours at 37° C. Bizarre forms with multiple axostyles, nuclei, and flagellar components were often observed in tubes incubated at low temperatures or in media without agar.

The utilization of certain sugars was determined by chemical analysis using washed cells suspended in Krebs-Ringer phosphate (pH 6.5) with the test sugar. *T. hominis* utilizes glucose, galactose, maltose, lactose, and sucrose. Using washed cells from cultures 12–48 hours old, the rate of glucose-utilization per milligram of total nitrogen was found to increase linearly with increasing age of the culture. These data are comparable with those obtained by Warren with *Trypanosoma cruzi* and differ from results obtained with *Escherichia coli*.

Using a triphenyltetrazolium assay, washed cells were shown to oxidize citrate, alpha-ketoglutarate, malate, beta-hydroxybutyrate, and glutamate. This seems to indicate that *T. hominis* possesses the enzymes of some form of the tricarboxylic acid cycle. The data are compared with similar information on other trichomonad species. (These studies were carried out under the direction of Dr. Clark P. Read and were supported by a grant (E-783) from the National Institutes of Health, U. S. Public Health Service.)

104. **Comparative pathogenicity of several strains of *Trichomonas gallinae* and *Trichomonas vaginalis* to mice.** B. M. HONIGBERG AND SABINA D. BRAUNTHAL, University of Massachusetts, Amherst.

A statistical analysis was made of the volumes of lesions produced by subcutaneous inoculations into C-57 Bl/6 mice, of 3 strains of *Trichomonas gallinae* grown in axenic cultures. This analysis suggests that the mean volumes reflect the pathogenicity of the strains to their natural hosts, pigeons.

Significant statistical differences could also be found among the mean volumes of lesions produced in mice through similar inoculations of 3 strains of *Trichomonas vaginalis*. Hence it can be assumed that these differences reflect the actual differences in virulence of the strains to man. Furthermore, only the Jones' Barn strain of *T. gallinae*, known for its extremely high virulence, seemed to be much more pathogenic to mice than the apparently most pathogenic strain of *T. vaginalis*. On the other hand, a mild strain of *T. gallinae*, isolated originally from Lahore pigeons by Stabler, was significantly less virulent to mice than the strains of the human parasite.

The results obtained in our experiments suggest that *T. vaginalis* is a truly pathogenic species. The method involving inoculations into mice provides a tool for evaluation of the relative virulence of various strains within and among pathogenic species of trichomonads. (This investigation was supported by a research grant, E742C, from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health, Public Health Service.)

105. **Further Observations on the Passage of Virulent *Trichomonas gallinae* through Successive Non-immune Domestic Pigeons.** ROBERT M. STABLER, Colorado College, Colorado Springs.

The author presented a summary of these serial transfers when the pigeons had reached a total of 119 birds (1953, J. Parasitol. **39** (Suppl.): 12). Of the present 300 pigeons, 293 were homers, 5 kings, 1 roller, and 1 half king-half homer. One hundred twelve were squabs, 89 were juveniles, 92 adults (age not stated in 7). The *T. gallinae* was always pipetted into the open mouths of the recipients. The material for infection was derived mainly from the liver (257 cases), with some coming from the mouth, the lungs, pancreas, etc. Two hundred forty-five birds were infected soon after the donor's death; 48 were dead 24 hours before their trichomonads were used.

Of these 300 pigeons, only 7 lived. The survival time of the 293 which succumbed ranged from 4 to 18 days, with an average of 7.6 days. Lesions were found variously in the brain, digestive tract anterior to the gizzard, in thoracic and abdominal viscera, and as contact extensions from the huge hepatic caseations onto several abdominal and thoracic organs.

106. **Intestinal Parasite Surveys on Indian Reservations in Montana, South Dakota, New Mexico, Arizona, and Wisconsin.** MARION M. BROOKE AND DOROTHY M. MELVIN, Communicable Disease Center.

During 1955 and 1956 intestinal parasite surveys were performed on 5 Indian reservations as a part of the comprehensive investigation of Indian health problems, conducted by the Division of Public Health Methods, Office of the Surgeon General, U. S. Public Health Service. The same laboratory methods were used in each survey. Stool specimens were examined by the formalin-ether concentration procedure (Ritchie 1948), and by permanently stained films after preservation in PVA fixative (Brooke and Goldman 1949). Vaseline-paraffin anal swabs (Markey 1950) were used in the examinations for *Enterobius vermicularis*.

Totals of 897 stool specimens and 1352 anal swabs revealed 69% of the Indians infected with 1 or more intestinal parasites. *Entamoeba histolytica* was found in 15%, ranging from 2 to 34% on the different reservations. The average prevalence of *E. vermicularis* was 16%, ranging from 10 to 25%. The most striking findings were the virtual absence of nematode infections and the rather low prevalence of any parasites on the reservation in Wisconsin as compared with the other 4. The parasitological results are analyzed in relation to several environmental and economic factors.

107. **The Effect of Changes in pH and Specific Gravity on the Recovery of Certain Helminth Eggs and Protozoan Cysts in the Formalin-ether (406th MGL) Fecal Concentration Technique.** M. M. WINN, A. P. MOON, S. S. LIN, S. ASAKURA AND H. YOSHIDA, 406th Medical General Laboratory, APO 343, San Francisco, California.

Ritchie *et al* (1956) reported on results obtained by changing the pH and specific gravity of the formalin used in the formalin-ether concentration technique. Ethyl alcohol, to give a final concentration of 20%, was added to formalin buffered at pH 4, 7 and 10. This reduced the specific gravity to different levels depending on the amount of buffer salt in the formalin. In the present study the same pH series was used, but the specific gravity was stabilized at 3 points, 0.945, 0.963 and 0.980.

Except for *Entamoeba histolytica* and *Endolimax nana* cysts the best results were obtained with pH 7, specific gravity 0.980. All helminth eggs and certain protozoan cysts were concentrated better, but the superiority of this solution was most pronounced in detecting *Schistosoma japonicum* eggs. Both the number of schistosome eggs recovered and the number of cases diagnosed were significantly higher with this reagent.

Another series of tests compared the standard method (formalin—pH 8.5, specific gravity 1.004) with the best of the modified techniques (formalin—pH 7, specific gravity 0.980). *E. histolytica* and *E. nana* cysts were concentrated better in the standard method, while *S. japonicum* eggs were recovered to a considerably greater degree in the modified procedure. Significant differences were not noted with the other parasites.

108. **On the Relation of the Biology of *Entamoeba invadens* to its Pathogenicity in Snakes.** EUGENE MEEROVITCH, Macdonald College of McGill University.

In vivo and *in vitro* studies on *E. invadens* have led to the interpretation of its pathogenicity in snakes and non-pathogenicity in turtles in terms of the physiological requirements of the amoebae. Encystation is a necessary stage in the life-cycle of parasitic amoebae; therefore, if the requirements for encystation are fulfilled in the intestinal lumen of the host, there need be no tissue invasion. Conversely, if the environment in the intestine does not furnish these requirements, the amoebae resort to feeding on the mucous secretion of the intestinal epithelium, and tissue invasion results.

One of the prerequisites for mass encystation *in vitro* of *E. invadens* has been shown to be the ingestion by the amoebae of particulate carbohydrate. Since the amoebae are compulsory phagotrophs, they are unable to utilize dissolved food. Solid carbohydrate in the form of starch is readily available in the intestine of turtles which are vegetarian, but is not present in the carnivorous snakes.

Extensive invasion by *E. invadens* of the tissues and a 100% death rate of the infected snakes have led to the belief that *E. invadens* must be an accidental parasite of snakes. The fact that snake infections have only been reported in captive animals, together with the isolation by the author of a strain of *E. invadens* from a naturally infected turtle, *Chrysemys picta*, have brought about the conviction that *E. invadens* is a natural non-pathogenic parasite of herbivorous turtles.

109. **Gregarines in Marine Crustacea Taken at Bombay, India.** G. H. BALL, University of California at Los Angeles.

Twenty-three species of marine Crustacea from the vicinity of Bombay were examined for gregarine parasites of the digestive tract. The majority of the crustacea were crabs, although a few prawns and shrimps were also examined. Among the species of crabs, infections were found in *Etisus laevimanus* (10% infected) and in *Matuta lunaris* (30% infected). About one-half of the specimens of the prawn, *Peneus semisulcatus* were parasitized by a third species of gregarine. The 3 species of gregarines are believed to be new; life-history stages will be described.

110. **The Distribution of *Toxoplasma gondii* in the Muscles of Rats with Chronic Infections.** LEON JACOBS AND MARJORIE L. MELTON, Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Maryland.

Toxoplasma persists in the brain of rats for years after infection, while the extraneural viscera become negative early. The persistence of toxoplasmas in musculature may be of importance in relation to infection of carnivores.

Rats infected with various strains of *T. gondii* were examined for parasites in the brain and in diaphragm, chest, abdominal, and leg muscles. The first procedure used was the grinding up and injection into mice of aliquot weights of these tissues. This resulted in occasional positive findings in muscles of rats in which the brain was also positive. To test larger amounts

of muscle, later tests used the procedure of feeding aliquot portions to mice, as well as inoculation. Feedings resulted in no more positive findings per sample, but because more samples were used, more muscles were found positive. Thus, toxoplasmas appeared irregularly distributed in muscles and small samples could yield false negatives.

By a third procedure, consisting of digestion followed by inoculation of washed sediment, muscles of rats infected with the CH and LB strains were found positive as long as 3 and 4 months respectively after infection. After 7 months, LB-infected rats were negative in both brain and muscles. Rats infected with strain 113-CE showed parasites in the brain for 6 weeks after infection; the muscles were never positive, and beyond 6 weeks all tissues were negative. One of 2 rats infected with RH parasites 6 months previously showed parasites in the brain and in abdominal muscle.

111. **Certain B Complex Vitamins as Growth-promoting Factors for** *Trichomonas gallinae*. IRA JONES AND B. F. SMITH, Spelman College, Atlanta, Georgia.

A strain of *Trichomonas gallinae* was maintained in stock cultures for 9 months in a medium which contained ribonucleic acid, cysteine hydrochloride, asparagine, vitamins, salts, and 5% human serum. In the preparation of experimental inocula 48-hour stock cultures were concentrated by centrifuge and washed several times with modified Ringers' solution. Approximately 150,000 of the washed organisms were inoculated into each of the tubes containing a basal medium with all the B-vitamins, and into tubes containing media deficient in each of the vitamins tested. The basal medium used was that of Sprince, Goldberg, Kucker and Lowy (1953) for *Trichomonas vaginalis*. At the end of 72 hours of incubation at 37° C the population densities of cultures were determined.

When nicotinamide, choline chloride, pyridoxamine, and calcium pantothenate were omitted from the medium separately, growth reductions at the end of 72 hours were 86%, 68%, 81%, and 86% respectively. Significantly high reductions were also observed in cultures deficient in pyridoxine, folic acid, and biotin at the end of the second serial transfer. The results of these experiments seem to indicate that the B vitamins mentioned above are essential for the growth of *T. gallinae*.

112. **The Effect of Lysozyme-Killed Bacteria on the Growth of** *Entamoeba histolytica*. MITSURU NAKAMURA, Montana State University.

Bacillus subtilis and *B. megaterium* were grown in nutrient broth for 72 hours and washed 3 times by centrifugation. The washed, packed cells were suspended in Ringer solution to obtain a 20% suspension of cells. One-ml aliquots of this suspension were treated by various methods to kill the cells. The killed cells were studied for their effects on the growth of *E. histolytica* by placing 0.2 ml of the suspension into a modified Boeck-Drbohlav medium which contained streptomycin and achromycin to inhibit the associated *Escherichia coli* introduced with the amebic inocula from stock cultures. The *Bacillus subtilis* and *megaterium* were killed by acetone, alcohol, mercuric chloride, chloroform, autoclaving, grinding in a ball mill, penicillin, and lysozyme treatments. Bacterial cells killed with lysozyme and penicillin possessed high ameba-stimulatory properties; cells prepared by autoclaving possessed a slight stimulatory activity; whereas, the preparations of bacterial cells treated by the other methods were without activity. The response was similar with either *B. subtilis* or *B. megaterium*. Dose-response experiments indicated that there was a direct relation between the quantity of penicillin- or lysozyme-treated cells added and the total amebic population up to a point where maximal effects were observed. It is possible that lysozyme- and penicillin-treatment results in cell preparations relatively undamaged with respect to cellular makeup and enzymatic systems, which accounts for their abilities to stimulate growth of amebas.

113. **Myxosporidiosis in Immature Sea Herring from the Gulf of Maine.** CARL J. SINDERMANN, U. S. Fish and Wildlife Service, Boothbay Harbor, Maine.

Probably no other parasite group is of more serious concern to commercial marine fisheries than the Myxosporidia, particularly those which invade the body musculature of the host, producing opacity and degeneration of tissue. The clupeid fishes, and notably the herring, are subject to infection by *Kudoa clupeidae* (Hahn 1918), which occurs in white, fusiform, opaque, intramuscular cysts in immature fish (Meglitsch, 1947, J. Parasitol. **33**: 271–277; Sindermann and Rosenfield 1954a, Maine Dept. Sea and Shore Fish., Res. Bull. No. **18**: 1–23). Examination of immature herring from many points in the Gulf of Maine has disclosed a remarkable lack of homogeneity in incidence of this protozoan parasite. Infections were found in up to 84% of 1-year-old fish in samples from the western Gulf, while infections were completely absent in fish of the same age from the eastern Gulf. Aquarium survival experiments did not demonstrate differential mortality of infected fish between the first and second years of life,

although it may occur earlier or later in the life history of the fish. This lack of homogeneity in distribution and apparent lack of differential mortality in immature fish suggested that the myxosporidian cyst might serve as a reliable "natural tag", and might prove to be a useful tool in understanding movements of herring and the existence and extent of intermixing of herring populations. Reexamination of the same age group of fish near the end of its second year of life has revealed a pattern of myxosporidian infection suggesting the absence of major movement of immature herring during the intervening period, and intermixing of less than 25% between eastern and western Gulf subpopulations. Since fish of this age have commercial importance as sardines, and since knowledge of herring movements is important to an understanding of the source of the raw material for the industry, parasitological studies such as these may contribute significantly to this and other research programs concerned with pelagic marine fish populations.

114. **Studies on the pathogenicity of *Ichthyosporidium hoferi*, fungus parasite of fishes.** CARL J. SINDERMANN, U. S. Fish and Wildlife Service, Boothbay Harbor, Maine.

Ichthyosporidium hoferi, a cosmopolitan fungus pathogen of marine and freshwater fishes, has been responsible for 5 recorded epidemics among marine fish populations, especially the sea herring, of the western North Atlantic, during the past 60 years. The most recent outbreak occurred from 1954 to 1956 in the Gulf of Saint Lawrence, where extensive mortalities of herring resulted (Leim, 1955, Fish. Res. Bd. Can., Prog. Rept. Atl. Sta. No. **62**: 30–32; Sindermann, 1956, Maine Dept. Sea and Shore Fish., Res. Bull. No. **25**: 1–23). While this outbreak was in progress in the Gulf of Saint Lawrence, the disease was at a low endemic level in the herring stocks of the Gulf of Maine, furnishing an admirable opportunity to study the disease in contrasting phases. Utilizing immature herring from the Gulf of Maine and goldfish from commercial sources as experimental animals, it was found that the virulence of the disease organism from both gulfs was similar. Culture growth rate and other characteristics were identical. Death of experimental herring due to acute infections resulted 20–40 days following initial massive exposure to fungus spores. Subacute infections, characterized by pronounced host cellular reaction, resulted from smaller dosages of spores. Results of these experiments can be related to observations of the disease outbreak in herring of the Gulf of Saint Lawrence, and indicate that (1) severity of infections increases with increasing infection pressure, and (2) resistance and individual variation in resistance of fish may be important in explaining the periodic changes in incidence that characterize this disease.

115. **Immune Precipitates on Nematode Parasites Studied *In vitro* with Fluorescent and Unlabeled Serums.** GEORGE J. JACKSON AND ROBERT M. LEWERT, Department of Microbiology, The University of Chicago.

Serums with a fluorescent label are being used to locate sites of antibody-antigen reaction in a variety of parasitic infections. Whole serums or crude globulin fractions are conjugated to fluorescein isocyanate according to the method of Coons (1950, J. Exper. Med. **91**: 35–44) or to 5-dimethylamino-1-naphthalene sulfonyl chloride according to the method of Weber (1952, Biochem. J. **51**: 156).

Precipitates form in, on or about nematode parasites incubated with serums of specifically immunized hosts. They do not form with "normal" serums and the precipitating ability of immune serums, located in the gamma globulin fraction, may be diminished or removed by absorbing with its specific antigens.

Experiments with *Trichinella spiralis* and rabbit serums are typical of other host-nematode parasite systems under investigation. Observed in near ultraviolet light the oral cap of precipitate on a larva which has been incubated with fluorescent immune serum and unlabeled normal serum and then washed, emits a bright yellow green fluorescence. The precipitate on a larva which has been incubated with fluorescent normal serum and unlabeled immune serum and washed, does not fluoresce in near ultraviolet light and is hardly visible although it can be seen in white light.

This experiment and specific absorption experiments indicate that the precipitate formed on *Trichinella spiralis* larvae in specific immune serum is an antibody-antigen mass, resulting from a reaction between the antibody of the immune host serum and antigens on the surface of the parasite or in its excretions.

116. **Serum-Agar Double Diffusion Studies with Ascaris Antigens. II. Analysis of Polysaccharide Antigens.** IRVING G. KAGAN* AND EDWARD L. JESKA, The University of Pennsylvania and The Pennsylvania Department of Health Laboratory. (*Present Address: Communicable Diseases Center, Chamblee, Ga.)

Ascaris polysaccharide (CHO) antigens were prepared by several methods and assayed

with the double diffusion method. Human *Ascaris* CHO showed 4 major bands and pig *Ascaris* CHO 5 major bands when prepared by alcoholic precipitation. From 2–5 minor bands appeared in full strength serum. Cross-reactions were observed against antisera of human, pig, dog and cat *Ascaris* species. Absorption and mutual dilution experiments with human and pig CHO antigens revealed no significant differences between these antigens when tested against whole worm antisera.

Saline extracts of pig *Ascaris* showed 6–7 major bands. After autoclaving, 5 bands were still present. Precipitation with alcohol yielded a CHO antigen with 5 bands. This antigen was positive with the Molisch, Millon and Biuret tests. Treatment with 30% trichloroacetic acid or shaking with chloroform and alcohol (Sevag's method) produced no change in the agar diffusion pattern or in the biochemical tests. The protein moiety of this antigen is being investigated by paper chromatography.

Whole worm pig *Ascaris* CHO prepared by Fuller's formamide method showed 4 bands. A CHO antigen extracted with Calcium Oxide and precipitated with HCl showed 2 bands. Cuticle CHO (alcohol) showed 6 bands and cuticle CHO (formamide) 1 band. Muscle CHO (acetone) showed 4 bands and muscle CHO (formamide) 2 bands. Nonembryonated egg CHO (acetone) showed 6 bands and CHO (formamide) 1 band. Enteric fluid CHO (alcohol) showed 4 bands and CHO (formamide) 2 bands. Embryonated egg CHO (formamide) showed 2 bands. Polysaccharide antigens prepared with formamide from muscle and nonembryonated eggs were similar antigens; however, cuticle CHO and nonembryonated egg CHO were antigenically distinct.

117. **Hemagglutination Studies with Ascaris Antigens.** IRVING G. KAGAN*. The University of Pennsylvania. (* Present Address: Communicable Disease Center, Chamblee, Ga.)

A variety of antigens prepared from whole worm and tissue extracts of 2 ascarid genera (*Ascaris* and *Toxocara*) have been successfully used in hemagglutination tests. Antisera were prepared against pig (*Ascaris lumbricoides var. suum*), human (*Ascaris lumbricoides*), dog (*Toxocara canis*) and cat (*Toxocara cati*) ascarids by injecting rabbits with whole worm antigens in Freund's adjuvant. Cross-reactions in the hemagglutination test were obtained with all antisera against antigens from each species. By selective absorption and hemagglutination inhibition, antisera against *Toxocara* or *Ascaris* species were serologically differentiated from each other. This demonstrated that crossreacting antibodies could be selectively removed by absorption, leaving generically specific antibodies which showed positive hemagglutination titers with antigens from the same genus. Antisera prepared in rabbits and guinea pigs by feeding viable eggs of pig, human and cat *Ascaris* species showed lower and weaker hemagglutination titers than antisera prepared by injecting antigen.

Polysaccharide antigens prepared from whole worm pig *Ascaris*, pig *Ascaris* cuticle and from human *Ascaris* will not adhere to sheep red cells that have not been sensitized with tannic acid.

118. **Differences in Susceptibility of Rice Rats and Cotton Rats to Various Strains of Filarial Worms.** J. ALLEN SCOTT, ETTA MAE MACDONALD AND JOHN H. CROSS, JR., The University of Texas Medical Branch at Galveston.

Rice rats of the subspecies *Oryzomys palustris palustris* from the Atlantic coastal region of Georgia harbor filarial worms which are probably morphologically identical to *Litomosoides carinii* of the cotton rat. The experiments reported in this paper show that these worms were readily transmitted to rice rats from the same vicinity by the tropical rat mite. Attempts to infect several rice rats of the subspecies *O. palustris natator* have all been unsuccessful. Attempts to infect 2 strains of cotton rats were also unsuccessful. As yet it has not been possible to infect either strain of rice rat with either of 2 strains of *L. carinii* from cotton rats. (Supported by National Science Foundation Grant 1213.)

119. **Glycolysis in *Trichinella spiralis* Larvae.** ERWIN GOLDBERG, State University of Iowa.

Magnesium- and ATP-fortified homogenates of the larvae of *T. spiralis* metabolize glucose to lactic acid anaerobically. The addition of hexose diphosphate to the reaction medium stimulates lactate production. No anaerobic CO_2 production by homogenates or intact larvae was observed.

Spectrophotometric assays to demonstrate the presence of the enzymes mediating the sequence of reactions involved in glycolysis have been carried out. The activities of lactic dehydrogenase, enolase and the zymohexase complex have been measured at the time of this report. These enzymes are present in the supernatant after centrifugation of the homogenate

at 10,000 × G for 10 minutes at 4° C, indicating that intracellularly they are either soluble or are localized in particles not sedimented under these conditions. The results presented indicate that a mechanism for phosphorylative glycolysis, similar to the Embden-Meyerhof scheme of vertebrate tissues, is present in the larvae of *T. spiralis*.

120. **Ultra-structure of** *Rhabditis strongyloides*. C. Robert Peebles, University of Illinois.

Ultra-thin sections of *Rhabditis strongyloides* were studied with an RCA-EMU-2e electron microscope equipped with a rear focal plane objective 30 microns in diameter. The nematodes were fixed best in a modified 1% osmium tetroxide solution buffered to pH 8.2. Ethanol extraction of osmium-fixed material was reduced by adding magnesium salts. N-propanol and isopropanol also reduced solution effects but decreased methacrylate infiltration.

The external cuticle of the adult consists of 1) a thermolabile surface membrane; 2) a cortical layer with canaliculi; 3) a layer with obliquely oriented fibers; and 4) a layer, with randomly arranged fibrils, which lies directly on the hypodermal membrane. The cortex of early larval cuticle lacks canaliculi. Subcortical, parallel columellae are oriented perpendicular to the hypodermis. Ecdysis is preceded by the formation of the new cuticle. The molting cuticle separates beneath the columellae.

Muscle fibers are intracellular, non-striated, and composed of numerous fibrillae. Invaginations of the cell membrane separate individual muscle fibers. Intercellular cement between the hypodermis and mucle cells extends into the invaginations.

The bacillary layer of the intestinal epithelium has the structure of a typical brush border; no evidence of ciliary structure was detected. The cytoplasm of the intestinal cells includes fatty globules, rhabditin granules, and concentrically arranged cytomembranes.

The excretory sinus, which is intimately associated with 2 large sinus cells, is lined with numerous microvilli. Microvilli were not observed in the lateral excretory canals.

121. *Ascaris laevis* **Migration in Experimental Hosts.** Bert B. Babero, The University of Illinois.

Eleven species of mammals, comprising 164 animals, were experimentally fed embryonated eggs of *A. laevis* and a number of infections were thus established. The "tracheal migration" was repeatedly observed and larvae were recovered periodically along the pathway from the circulatory system, liver and lungs. Pathological lesions were observed frequently in these organs, especially the former. Generally, the migratory cycle was more prolonged and the growth and development of the parasite was slower than that reported for *A. lumbricoides*.

122. **The Development of** *Toxocara canis* **(Werner 1782) in the Dog.** J. F. A. Sprent, University of Queensland.

Dogs of various ages were examined at autopsy for infection with *T. canis*. At birth, third-stage larvae were found in the lungs and were found there throughout the first week of life. By 3 days larvae had reached the intestine and had molted for the third time. At 9 days the adult stage was reached and at 23 days eggs were passed. All of 29 puppies between 1 and 6 months were infected with adult *T. canis*, while 3 out of 29 dogs over 6 months were infected.

Dogs were experimentally infected with embryonated eggs, and by feeding them with mice harboring larvae in their tissues. In the egg-infected group, when infection took place between birth and 3 weeks, full development to the adult occurred; in older dogs development did not proceed beyond the second-stage larvae and these were restricted to the somatic tissues. In the mouse-infected group full development occurred in dogs and foxes 3–7 weeks old, but not in older dogs.

Development closely resembled that of *T. cati;* second-stage larvae occurred in various tissues (length 0.335–0.444 mm); third-stage larvae occurred in lungs and stomach (length 0.460–1.19 mm); fourth-stage larvae occurred in intestine (length 1.20–6.3 mm). The second molt was observed in liver, lungs, heart and stomach wall at 0.38–0.46 mm, the third molt in lungs and stomach at 0.95–1.3 mm, and forth molt in intestine at 5.3–7.4 mm.

Three methods of infection were demonstrated: prenatal infection; postnatal infection by eggs and postnatal infection through ingestion of infected mice. Postnatal infection appears to occur only in puppies.

123. **The Axenic Cultivation of** *Strongyloides ratti* **and** *Strongyloides sp.* **from the Rhesus Monkey.** Paul P. Weinstein and Myrna F. Jones, Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Maryland.

Filariform larvae have developed from the eggs of both species under axenic conditions.

In the case of *S. ratti*, these larvae have given rise to normal infections in rats; no animal infections have been attempted with those derived from the monkey.

The strain of *S. ratti* has developed primarily in a homogonic fashion on bacterial cultures (charcoal); a low percentage heterogonically. In axenic cultures, only homogonic development has so far been observed.

S. sp. (from *Rhesus*) has behaved primarily heterogonically on bacterial cultures (charcoal). Similarly, under axenic conditions both "direct" and "indirect" development have occurred in the same flasks. The nutritional requirements for homogonic development, however, appear "simpler" than for heterogonic, since normal filariform larvae have been obtained on a variety of media, while only incomplete growth of heterogonically developing organisms has occurred. Males have developed normal spicules, but the testes have remained immature; only a few have formed sperm. Females have similarly exhibited incomplete growth, only a very low percentage showing egg formation; eggs have been infertile.

Culture media have consisted primarily of fresh tissue homogenate (chick embryo) alone, and supplemented with various growth factors.

No development of the "parasitic" stages of either species has as yet occurred *in vitro*, even in media in which *Nippostrongylus muris* has developed to sexually mature adults.

124. **The Axenic Cultivation of** *Nematospiroides dubius*. MYRNA F. JONES AND PAUL P. WEINSTEIN, Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Maryland.

The development of *N. dubius* has been obtained from the egg to the fifth stage *in vitro* under axenic conditions. Fresh tissue homogenate (chick embryo) has supported good development of the free-living stages, and when supplemented with liver concentrate (Sigma), more than 90% yields of filariform larvae have occurred consistently. These larvae have given rise to normal infections in mice. Mass cultures have proved successful, as many as 70,000 filariform larvae having been reared in a single experiment. In a comparable experiment with *Nippostrongylus muris* twice this number was obtained. These data indicate that axenic cultivation procedures are reasonably applicable to problems requiring large numbers of sterile organisms.

In preliminary experiments, filariform larvae have developed to the fifth stage *in vitro* in media consisting of high concentrations of embryo homogenate and rat serum, but the worms so far have not reached sexual maturity.

125. **Paper Chromatography of** *Nippostrongylus muris* **Larvae.** FREDERICK FRIEDMAN AND IRVING G. KAGAN*. The University of Pennsylvania. (* Present Address: Communicable Diseases Center, Chamblee, Ga.)

Ascending and descending chromatograms of *Nippostrongylus muris* larvae revealed the presence of 5 ninhydrin-positive areas in unidimensional papers and 7 areas in 2-dimensional papers. In addition, 2 fluorescent areas were present. The free amino acids are believed to be aspartic acid (confirmed), glutamic acid (suspected), glycine (confirmed), hydroxy-phenol amino acid (suspected), an unknown, and tryptophan (suspected). One fluorescent area showed a brown spot with aniline oxalate at an Rf .77 with phenol. The solvents used were phenol for the first dimension and a mixture of butanol, acetic acid, water for the second dimension.

Chromatograms of living, frozen, and lyophilized larvae as well as the water medium surrounding frozen larvae gave very similar patterns. Lyophilized material had a tendency to streak on the paper. Hydrolysates of the above materials yielded similar patterns except that spot 4 (glutamine) decreased in intensity and spot 2 (glutamic acid) increased in intensity and size. A new spot between glutamic acid and glycine was also noted.

126. **Unidentified Factors Required by** *Caenorhabditis briggsae* **(Nematoda). I. Factors Rb and Cb.** ELLSWORTH C. DOUGHERTY AND EDER LINDSAY HANSEN, University of California (Berkeley).

Recent studies have demonstrated more clearly the existence of 2 as yet unidentified factors (or sets of factors) required for the axenic cultivation of *C. briggsae*. Both occur (Dougherty and Hansen, 1956, *Proc. Soc. Exper. Biol. Med.* **93**: 223–227) in the 2 crude fractions (LPF-C and ALE) that make up the liver medium (LM) on which stock cultures have been maintained since late 1954. One, best provided by LPF-C, is relatively heat-labile and seems protein-like; it has the properties originally attributed to *factor Rb*. The other, best provided by ALE, is heat-stable and, by recent evidence, of relatively small molecular size; it may be called *factor Cb* (after *C[aenorhabditis] b[riggsae]*). We have now found

that 10% LM in defined medium GM-11 gives near maximal growth (maturation and reproduction in 5 days), which is faster than on full-strength LM, and that, if either LPF-C or ALE alone is used instead of LM, growth is considerably slowed. The system (GM-11) × 2 + LPF-C @ 10% provides a satisfactory basal system for assaying various sources for *factor Cb*, as described in the following abstract. [Contribution no. 9 from the Laboratory of Comparative Physiology and Morphology of the Kaiser Foundation; work reported in this and immediately following abstract has been supported by Grant E-926 of the National Institute of Allergy and Infectious Diseases, N.I.H., U.S.P.H.S.]

127. **Unidentified Factors Required by** *Caenorhabditis briggsae* **(Nematoda). II. An assay system for Factor Cb.** ELLSWORTH C. DOUGHERTY AND EDER LINDSAY HANSEN, University of California (Berkeley).

(GM-11) × 2 + (LPF-C) brought to final concentration with distilled water, permits maturation of *C. briggsae*, with first larvae appearing at not less than 7½ days. Certain crude materials (*e.g.*, ALE, as noted) are markedly stimulatory when added in place of distilled water. ALE is replaceable with equivalent amounts (by dry weight) of Wilson's Liver Fraction L, of which a fraction can in turn be substituted, separated by 2 hours ascending chromatography in the solvent system: isopropanol-pyridine-water-acetic acid (8:8:4:1) (Gordon and Hewel, 1955, *Analyt. Chem.* **27**: 1471–1474). For this, Fraction L is streaked in a narrow band parallel to 1 edge of a large piece of Whatman no 4. filter paper, which is then folded as a cylinder with the streak parallel to 1 end; that end is next placed in a shallow solvent layer within a closed system, the streak not being immersed. After the run, the cylinder is removed and dried, and cuts made. Activity is recoverable from a strip representing R_f 0.4–1.0. To release residual pyridine, one should treat the dried strip with a freshly prepared mixture of concentrated NH_4OH and pure acetone (5:95), then redry. Water elution is finally done by capillary flow. Factor Cb appears not to be a substance of high molecular weight (*e.g.*, polypeptide) because of relatively high mobility in this solvent system. Current work is directed toward narrowing the active band, with the ultimate aim of characterizing Factor Cb chemically. [Contribution no. 10 from the Laboratory of Comparative Physiology and Morphology of the Kaiser Foundation.]

128. **Infection with** *Enterobius* **in Egypt.** J. ALLEN SCOTT, The University of Texas Medical Branch at Galveston.

A recent report by Headlee (1956, Parasitol. **42** (Suppl.): 13) has stimulated a belated review of data on infection with *Enterobius vermicularis* in Egypt between 1930 and 1937. The study is based on examination of approximately 32,000 persons representing the same individuals included in a report on hookworm disease (Scott, J. A. 1937, Am. J. Hyg. **26**: 455) except for omission of all cases in Fayum province. Since the data are based on dilution egg counts, they have only comparative value.

The rates for different villages ranged from 1 to 16%, averaging 5.8%. The geographical differences did not form a consistent pattern nor were they associated with known environmental differences. There are no appreciable differences between sexes or various age groups except that the youngest group examined, ages 3 to 4 years, have a slightly lower rate than the older groups.

The number of eggs per unit volume did not vary much geographically or by age and sex groups. The egg count was approximately log normal but truncated at the lower limit of counting. About 50% of the 1853 positive cases had counts above 550, 10% above 1550 and 1% above 3800. Restoring the truncated portion of the curve by use of second ratios raised the prevalence to 6.4%, which figure probably represents fairly well the proportion with eggs or worms in the stools on any one day. Wells and Blagg (1956 Am. J. Trop. Med. and Hyg. **5**: 266) recorded this species in 2% of the stools in a village at the periphery of the areas in this survey.

129. **Life History Studies on** *Porrocaecum ensicaudatum*, **an Avian Nematode.** NORMAN L. LEVIN, University of Illinois.

Porrocaecum ensicaudatum, a parasitic nematode of ground-feeding birds in parts of Europe and North America, is reported in Illinois for the first time. The helminth was recovered from the intestine of the robin, starling and grackle.

Certain facts of the life history of *Porrocaecum ensicaudatum* are revealed by experimental infections of the robin, chicken, starling, grackle, pigeon, domestic duckling, crow and white mouse. Results from the chicken, robin and starling indicate that these birds can

act as hosts; data from the others were inconclusive or negative. Infective larvae are located in the ventral blood vessel and hearts of *Lumbricus terrestris* and *Octolasium lacteum*. Within an hour after ingestion by the definitive host, the parasite begins to penetrate the horny layer of the gizzard. Exsheathing of infective larvae is accomplished by the 48th hour between the horny layer and muscle wall of the gizzard. By the 3rd day the parasite is found in the duodenal wall; the female reproductive system has started to develop. Rudiments of testes are noted on the 5th day. The spicule sheath opens into the cloaca by the 10th day when preparation for the second molt is observed. Completion of ecdysis occurs generally on the 14th day. Emergence from the intestinal tissue to the lumen begins on the 18th day with subsequent growth. Although smaller, the worm resembles the adult at this stage.

Furthermore, these studies have shown that *Spiroptera turdi* Molin is the larval form of *Porrocaecum ensicaudatum*.

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1953	CORNELIUS B. PHILIP	ELERY R. BECKER	HAROLD W. BROWN
1954	ELERY R. BECKER	CLAY G. HUFF	DONALD B. MCMULLEN
1955	CLAY G. HUFF	ELOISE B. CRAM*	GILBERT F. OTTO
1956	ELOISE B. CRAM*	GILBERT F. OTTO	AUREL O. FOSTER

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Secretary

HORACE W. STUNKARD	1933–34; 1935–36; 1937
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JAMES T. CULBERTSON	1942–43; 1944–45; 1946–47
HAROLD W. BROWN	1948–49; 1950–51
ARTHUR C. WALTON	1952–53; 1954–55; 1956
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CHARLES W. STILES*	1925; 1929–32	GILBERT F. OTTO	1942–44; 1945–48
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ERNEST C. FAUST	1931–34; 1938–41	ARTHUR C. WALTON	1951
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NORMAN R. STOLL	1933–36; 1937–40; 1941	ALLEN MCINTOSH	1953–56
ELOISE B. CRAM*	1934–37	DONALD V. MOORE	1953–56; 1957–
WILBUR A. SAWYER*	1934–37	AUREL O. FOSTER	1954–55; 1957–
JAMES E. ACKERT	1935–38	LLOYD E. ROZEBOOM	1954–
EARL C. O'ROKE	1936–39	LUTHER O. NOLF	1955–
JUSTIN ANDREWS	1937–40	LESLIE A. STAUBER	1955–
H. J. VAN CLEAVE*	1938–41	FRANCIS J. KRUIDENIER	1956–
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BENJAMIN SCHWARTZ	1933–37; 1938–41; 1942–45
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H. J. VAN CLEAVE*	1937–40
W. W. CORT	1938–41; 1942–45; 1946–47; 1949; 1950–53; 1954
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E. R. TYZZER	1939–42
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H. W. MANTER	1940–43
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W. L. JELLISON	1945–48; 1949–52; 1953–54
C. W. REES	1945–48
L. A. SPINDLER	1945–48; 1951–54
R. M. CABLE	1946–48; 1951–54; 1955–
L. E. ROZEBOOM	1946–49
R. J. PORTER	1947–50
WILLAM TRAGER	1947–50
A. C. WALTON	1947–50
G. H. WHARTON	1948–51
E. E. BYRD	1949–52; 1953–56

G. R. COATNEY	1949–52; 1953–56	C. G. GOODCHILD	1955–
M. D. YOUNG	1951–54	P. E. THOMPSON	1955–
ALLEN MCINTOSH	1952–55; 1956–	G. M. KOHLS	1955–56; 1957–
L. J. OLIVIER	1952–55	R. BARCLAY MCGHEE	1956–
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H. W. STUNKARD	1954–	C. P. READ	1957–

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List of Meeting Places

1925	Kansas City	1933	Boston	1942	New York (cancelled)	1950	Cleveland
1926	Philadelphia	1934	Pittsburgh	1943	(No meeting)	1951	Chicago
1927	Nashville	1935	St. Louis	1944	Cleveland	1952	Ithaca
1928	New York	1936	Atlantic City	1945	St. Louis	1953	Madison
1929	Des Moines	1937	Indianapolis	1946	Boston	1954	Memphis
1930	Cleveland	1938	Richmond	1947	Chicago	1955	Atlanta
1931	New Orleans	1939	Columbus	1948	New Orleans	1956	Storrs
1932	Atlantic City	1940	Philadelphia	1949	New York	1957	Philadelphia
		1941	Dallas				

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LIFE MEMBERS

Date Elected

Ackert, James E.—Kansas State College of Agriculture, Manhattan, Kan. 1956
Riley, William A.—Walker Methodist Home, 3701 Bryant Ave., S., Minneapolis 9, Minn. 1953
Tyzzer, Ernest E.—175 Water St., Wakefield, Mass. 1953

FOREIGN HONORARY MEMBERS

BAER, JEAN G.—Zoological Institute, University, Neuchatel, Switzerland 1952
BAYLIS, HARRY A.—British Museum (Natural History), Cromwell Rd., London, S.W. 7, England 1932
COVELL, MAJOR GENERAL SIR GORDON—Malaria Laboratory, Horton Hospital, Epsom, Surrey, England 1952
MARTINI, ERIC—Institut für Schiffs- Und Tropenkrankheiten, Hamburg, Germany 1932
SERGENT, EDMOND—l'Institut Pasteur d'Algerie, Algerie, North Africa 1932
SHORTT, HENRY, E.—London School of Hygiene and Tropical Medicine, Gower St., London, England 1948
SKRJABIN, PROF. K. J.—All-Union Institute of Helminthology, Moscow, U.S.S.R. 1932
SWELLENGREBEL, NICHOLAAS H.—Institute for Tropical Hygiene, Mauritskade 57, Amsterdam, Netherlands 1939
TRAVASSOS, LAURO P.—Instituto Oswaldo Cruz, Rio de Janeiro, Brazil 1938
VOGEL, HANS—Institut für Schiffs- Und Tropenkrankheiten, Hamburg, Germany 1952

ACTIVE MEMBERS

ABADIE, STANLEY H.—Department of Microbiology, Louisiana State University Medical School, 1542 Tulane Ave., New Orleans, La. 1956
ACTOR, PAUL—955 Bergen Ave., North Brunswick, N. J. 1957
ADAMS, J. ALFRED—New York State Agricultural Experiment Station, Cottage Road, Poughkeepsie, N. Y. 1934
ADAMS, JAMES R.—Department of Zoology, University of British Columbia, Vancouver, British Columbia, Canada 1948
AGUILAR, FRANCISCO J.—Colonia 25 De Junio, 14 Ave. 23-35, Zones Guatemala City, Zone 5, Guatemala, C. A. 1954
ALDRICH, DAVID V.—U. S. Fish & Wild Life Service, Ft. Crockett, Galveston, Texas. 1955
ALEXANDER, CLAUDE G.—2931 Emerson St., Palo Alto, Calif. 1952
ALEXANDER, ELIZABETH P. SILVER—2931 Emerson St., Palo Alto, Calif. 1954
ALGER, NELDA E.—111 E. 26th St., Apartment D-9, New York, N. Y. 1953
ALICATA, JOSEPH E.—University of Hawaii, College of Agriculture, Box 18, Honolulu, T. H. 1929
ALICNA, ADRIANO D.—Tunnell Hill Rd., Rt. #1, Elizabethtown, Ky. 1953
ALLEN, KENNETH W.—Department of Biology, Rice Institute, Houston, Texas 1956
ALLEN, REX W.—P.O. Box 518, State College, N. Mex. 1942
ALLISON, LEONARD N.—State Fish Hatchery, Grayling, Mich. 1934
ALMODOVAR, ALEJANDRO AYALA—Department of Nematology, Agricultural Experiment Station, Reo Piedras, Puerto Rico 1956
ALVAREZ, JULIO—P.O. Box 887, Guayaquil, Ecuador, South America 1948
ALVES-MEIRA, JOAO—Rua Atlantica 481, Sao Paulo, Brazil, South America 1945
AMEEL, DONALD J.—Department of Zoology, Kansas State College, Manhattan, Kan. 1927
AMREIN, YOST U.—456 Harrison Ave., Claremont, Calif. 1950
ANASTOS, GEORGE—Department of Zoology, University of Maryland, College Park, Md. 1953
ANDERSON, CYRUS V.—Box 35, Minnesota City, Minn. 1940
ANDERSON, DORCAS J.—Kent State University, Kent, Ohio 1944
ANDERSON, EVERETT—3209 Sampson St., Houston 4, Texas 1952
ANDERSON, MARLOWE G.—New Mexico State College of Agriculture and Mechanical Arts, State College, N. Mex. 1930
ANDERSON, ROY C.—Department of Parasitology, Ontario Research Foundation, 43 Queens Park, Toronto 5, Ontario, Canada 1955

[1] In the present list the names of charter members are indicated by boldface type. The last complete list of members was published in Section 2 (Supplement) of the October issue, Vol. 40, 1954.

ANDREWS, JEAN GRANT—8 North Drive, Bethesda 14, Md. 1949
ANDREWS, JOHN S.—10314 Naglee Rd., Silver Spring, Md. 1930
Andrews, Justin M.—National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda 14, Md.
ANNERAUX, RALPH F.—Animal Pathology Laboratory, U. S. Department of Agriculture, Sacramento 14, Calif. 1931
ANTHONY, JAMES D.—Wisconsin State College, 3203 Downer Ave., Milwaukee, Wis. 1948
ARAI, HISAO P.—16303 S. Dalton Ave., Gardena, Calif. 1953
ARANT, FRANK S.—Department of Zoology and Entomology, Alabama Polytechnic Institute, Auburn, Ala. 1939
ARMER, SISTER JOSEPH MARIE—Incarnate Word College, San Antonio 9, Texas 1948
ARNOLD, JOHN G., JR.—Department of Medical Technology, Loyola University, New Orleans 18, La. 1934
ASH, LAWRENCE ROBERT—Department of Public Health & Tropical Medicine, Tulane University Medical School, 1430 Tulane Ave., New Orleans 12, La. 1956
ASHTON, DERYEE, JR.—219 E. Vanderbilt Drive, Oak Ridge, Tenn. 1952
ATCHLEY, FLOYD O.—Cumberland Field Station, P.O. Box 147, West Prestonsburg, Ky. 1932
Augustine, Donald L.—Department of Tropical Public Health, Harvard School of Public Health, Boston 15, Mass.
AUGUSTSON, GEORGE F.—820 South St., Madera, Calif. 1941
AXMAN, SISTER M. CLAUDINE—Sacred Heart College, 3100 McCormic Ave., Wichita 12, Kan. 1948
BABERO, BERT B.—Fort Valley State College, Fort Valley, Ga. 1950
BACHA, WILLIAM—120 West 183rd St., New York 53, N. Y. 1957
BACHMAN, GEORGE W.—3025 Ontario Rd. N.W., Washington 9, D. C. 1926
BAER, HAROLD G.—Ontario Veterinary College, Guelph, Ontario, Canada 1955
BAILEY, WILFORD S.—School of Veterinary Medicine, Alabama Polytechnic Institute, Auburn, Ala. 1947
BAIR, THOMAS D.—Department of Biological Sciences, Los Angeles State College, 855 North Vermont Ave., Los Angeles 29, Calif. 1952
BAKER, DONALD W.—New York State Veterinary College, Cornell University, Ithaca, N. Y. 1932
BALAMUTH, WILLIAM—Department of Zoology, University of California, Berkeley 4, Calif. 1945
Ball, Gordon H.—Department of Zoology, University of California, 405 Hilgard Ave., Los Angeles 24, Calif.
BALL, WILLIAM—5800 N. Park Ave., Philadelphia 41, Pa. 1949
BALLANTYNE, DONALD L., JR.—59 Dalebrook Rd., Bloomfield, N. J. 1949
BALLING, JAN WALTER—1242 Cherokee Rd., Louisville, Ky. 1957
BAND, RUDOLPH NEAL—Zoology Department, University of California, Berkeley 4, Calif. 1957
BANG, FREDERIC B.—John Hopkins School of Hygiene, 615 N. Wolfe St., Baltimore 5, Md. 1954
Bangham, Ralph. V.—Biology Department, College of Wooster, Wooster, Ohio
BANKS, WILLIAM M.—Department of Natural Science, Grambling College, Grambling, La. 1950
BARBER, IOLA W.—Department of Parasitology, University of California, Berkeley 4, Calif. 1952
BARON, ROBERT R.—Department of Zoology, Kansas State College, Manhattan, Kan. 1957
BARR, A. RALPH—Department of Entomology, University of Kansas, Lawrence, Kan. 1955
BARRETT, JOHN P.—Research Division, Armour & Company, Union Stock Yards, Chicago 9, Ill. 1940
BARRON, CHARLIE N.—Armed Forces Institute of Pathology, Walter Reed Army Medical Center, Washington 25, D. C. 1952
BARROW, JAMES H., JR.—Box 152, Hiram, Ohio 1956
BARRY, CORNELIUS M.—Department of Zoology, University of Maryland, College Park, Md. 1956
BASNUEVO Y ARTILES, JOSE G.—Edificio Fosca, 17 y M, Apto. 60M, Vedado, Habana, Cuba 1940
BASSETT, LUCY W.—P.O. Box 4172, Los Angeles 24, Calif. 1952
BATTE, EDWARD G.—Department of Animal Industry, North Carolina State College, Raleigh, N. C. 1952
BATTEN, PETER, J., JR.—Fairview Home, 2250 Strong Rd., Salem, Ore. 1949

BAUMAN, PRESTON M.—Department 463, Abbott Laboratories, 14th & Sheridan Rd., North Chicago, Ill. 1957
BEAVER, PAUL C.—Department of Tropical Medicine, Tulane University, New Orleans, La. 1929
BEAUDOIN, RICHARD L.—Box 395, Vetville 22C, Notre Dame, Ind. 1956
BECK, D. ELDON—Department of Zoology, Brigham Young University, Provo, Utah 1949
BECK, J. WALTER—Department of Bacteriology, University of Miami School of Medicine, Coral Gables 46, Fla. 1949
BECKER, DAVID, A.—Department of Zoology, University of Nebraska, Lincoln 8, Neb. 1955
Becker, Elery R.—413 Lynn St., Ames, Iowa
BECKLUND, WILLARD W.—Georgia Coastal Plains Experiment Station, USDA Animal Disease & Parasite Branch, Tifton, Ga. 1949
BEILFUSS, ERWIN R.—Division of Natural Sciences, Humboldt State College, Arcata, California 1953
BELKIN, JOHN N.—Division of Entomology, University of California, College of Agriculture, Los Angeles 24, Calif. 1942
BELL, SAMUEL D., JR.—695 Huntington Ave., Boston 15, Mass. 1946
BELL, THEODORE L.—Millikin University, Decatur, Ill. 1955
Benbrook, Edward A.—Division of Veterinary Pathology, Iowa State College, Ames, Iowa
BENNETT, HARRY J.—Department of Zoology, Louisiana State University, Baton Rouge 3, La. 1933
BENNINGTON, ELWIN W.—6416 Peachtree Dunwoody, Atlanta 19, Ga. 1942
BERBERIAN, DICRAN A.—389 Loudonville Rd., Loudonville, N. Y. 1939
BERBERIAN, JOSEPH F.—3727 South 23rd St., Omaha 7, Neb. 1952
BERG, EDWARD—Department of Biology, New York State College for Teachers, State University of New York, Albany, N. Y. 1952
BERNARD, GEORGE R., JR.—4501 Perlita St., New Orleans 22, La. 1953
BERNSTEIN, EMIL—Department of Zoology, University of Connecticut, Storrs, Conn. 1952
BERRY, JEWEL EDWARD—Box 2651, Prairieview, Texas 1952
BERTULLO, VICTOR H.—Department of Fisheries Investigations, Veterinary University, Larranga 1550, Montevideo, Uruguay 1954
Bishopp, Fred C.—8014 Piney Branch Rd., Silver Spring, Md.
BLECHMAN, MARTIN G.—Apartment 56, 40 Prospect Ave., Hackensack, N. J. 1952
BOGITSH, BURTON J.—Department of Biology, University of Virginia, Charlottesville, Va. 1956
BOISVENUE, RUDOLPH J.—Sanitation Research Section, Ralston Purina Co., St. Louis 2, Mo. 1953
BOOTH, ERNEST S.—Department of Biology, Walla Walla College, College Place, Wash. 1949
BOUCHARD, J. LOUIS—Department of Biology, Northwestern State College, Alva, Okla. 1949
BOURNS, THOMAS K. R.—Department of Biology, Queens University, Kingston, Ontario, Canada 1950
BOYD, ELIZABETH M.—Department of Zoology, Mount Holyoke College, South Hadley, Mass. 1946
BOYD, GEORGE H.—Graduate School, University of Georgia, Athens, Ga. 1928
BRACKETT, STERLING—Lederle Laboratories Division, American Cyanamid Company, 30 Rockefeller Plaza, New York 20, N. Y. 1938
BRADBURY, ORA C.—Box 7224, Reynolds Station, Winston Salem, N. C. 1927
BRADLEY, RICHARD E.—Department of Pathology and Hygiene, College of Veterinary Medicine, University of Illinois, Urbana, Ill. 1953
BRANCH, HAZEL E.—3756 E. Douglas Ave., Wichita 8, Kan. 1928
BRANDT, MILO C.—Biological Research Division, Lilly Research Laboratories, Indianapolis 6, Ind. 1949
BRAVO-HOLLIS, MARGARITA—Montes Elbruz No. 165, Mexico 10, D.F., Mexico 1956
BRENNAN, JAMES MARKS—Rocky Mountain Laboratory, Hamilton, Mont. 1946
BRIGGS, NORMAN T.—Department of Preventive Medicine & Public Health, University of Texas Medical Branch, Galveston, Texas 1955
BRITT, H. GRADY—P.O. Box 7223, College Station, Winston-Salem, N. C. 1946
BRODY, GERALD—Research Department, Moorman Manufacturing Company, Quincy, Ill. 1952
BROOKE, MARION M.—P.O. Box 185, U. S. Public Health Service, Chamblee, Ga. 1938
BROOKMAN, BERNARD—P.O. Box 126, Silver Spring, Md. 1946
Brown, Harold W.—Columbia University School of Public Health, 600 West 168th St., New York 32, N. Y.
BROWN, ROYAL L.—3956 Oakwood Pl., Riverside, Calif. 1956
BUCHHEIT, J. ROBERT—1444 Taylor St., N.W., Washington 11, D. C. 1954

BUCKBINDER, JACK—131 Vroom St., Jersey City, N. J. 1955
BULLOCK, WILBUR L.—Department of Zoology, University of New Hampshire, Durham, N. H. 1950
BURCHAM, ELDEN G.—Department of Zoology, University of Kentucky, Lexington, Ky. 1952
BURNS, WILLIAM C.—Department of Zoology, University of Wisconsin, Madison, Wis. 1955
BURROWS, ROBERT B.—The Wellcome Research Laboratories, Tuckahoe 7, N. Y. 1944
BURTON, GEORGE J.—P.O. Box 142, Times Square Station, New York 36, N. Y. 1950
BURTON, PAUL R.—Department of Zoology, University of North Carolina, Chapel Hill, N. C. 1957
BUTLER, J. MILES—Jusmag: Attn: USOM, APO 74—Box B, San Francisco, Calif. 1950
BUTTREY, BENTON W.—University of South Dakota, Vermillion, S. D. 1955
BYRD, ELON E.—Department of Zoology, University of Georgia, Athens, Ga. 1934
BYRD, MITCHELL A.—Department of Biology, College of William and Mary, Williamsburg, Va. 1954
CABALLERO Y C., EDUARDO—Apartado Postal Num. 692, Mexico, D.F., Mexico 1935
CABLE, RAYMOND M.—Department of Biological Sciences, Purdue University, West Lafayette, Ind. 1933
CALLENDER, MAURICE E.—Research Division, Eli Lilly & Co., Indianapolis, Ind. 1950
CAMERON, JOHN A.—College of Dentistry, Baylor University, Dallas, Texas 1935
CAMERON, THOMAS W. M.—Macdonald College, Quebec, Canada 1932
CAMIN, JOSEPH H.—Chicago Academy of Sciences, 2001 N. Clark St., Chicago 14, Ill. 1948
CAMPBELL, CHARLES H.—Orient, Long Island, N. Y. 1950
CAMPBELL, WAYNE—Department of Zoology, University of Oklahoma, Norman, Okla. 1955
CAMPBELL, WILLIAM C.—Merck Inst. for Therapeutic Research, Rahway, N. J. 1954
CANTRELL, WILLIAM F.—University of Louisville School of Medicine, 101 W. Chestnut St., Louisville 2, Ky 1941
CARDENAS-MONTERO, M. ALFREDO—530 Monjitas St., Santiago, Chile 1944
CARVER, RUSSELL K.—P.O. Box 185, C.D.C., Chamblee, Ga. 1954
CASE, ARTHUR A.—School of Veterinary Medicine, University of Missouri, Columbia, Mo. 1940
CASTILLO, ROBERTO LEVI—P.O. Box 3606, Guayaquil, Ecuador, South America 1944
CAUSEY, OTTIS R—Caixa Postal 636, Belem, Para, Brazil, South America 1929
CAUTHEN, GEORGE E.—Texas Agricultural Experiment Station, Angleton, Texas 1931
CHAMBERLAIN, ROY W.—P.O. Box 61, Communicable Disease Center, U.S.P.H.S., Montgomery 1, Ala. 1947
CHAN, KAM-FAI—School of Public Health & Administrative Medicine, Columbia University, 600 W. 168th St., New York 32, N. Y. 1950
Chandler, Asa C.—Department of Biology, Rice Institute, Houston, Texas
CHANG, PATRICIA C. H.—The Johns Hopkins School of Hygiene, 615 N. Wolfe St., Baltimore 5, Md. 1954
CHAPMAN, J. W.—Walterboro, S. C. 1945
CHAO, JOWETT—U.C.L.A., Los Angeles, Calif. 1955
CHAVEZ, CARLOS E.—Berlin 9714, Miraflores, Lima, Peru 1956
CHEN, SUI-FONG—4529 Middleton Lane, Bethesda, Md. 1944
CHENG, THOMAS C.—Miller School of Biology, University of Virginia, Charlottesville, Va. 1952
CHERNIN, ELI—Department of Tropical Public Health, Harvard School of Public Health, 25 Shattuck St., Boston 15, Mass. 1948
CHERNOFF, HARRY A.—584 Linwood Ave., Buffalo 9, N. Y. 1945
CHING, HILDA L.—Department of Zoology, University of Nebraska, Lincoln 8, Neb. 1957
CHITWOOD, MAY BELLE—Fulton, Md. 1939
CHOQUETTE, LAURENT P. E.—Ministry of Health, 1570 St. Hubert St., Montreal, Quebec, Canada 1948
CHU, GEORGE W.—Department of Bacteriology, University of Hawaii, Box 18, Honolulu 10, T. H. 1952
CHUN-HOON, HARRY C. F.—643 Jackson St., Denver, Colo. 1954
CHURCHILL, HELEN—Hollins College, Hollins, Va. 1939
CHUTE, ROBERT M.—Department of Biology, Middlebury College, Middlebury, Vt. 1950
CIORDIA, HONORICO—USDA Agricultural Research Service, Experiment, Ga. 1949
CLARK, DAVID T.—School of Veterinary Medicine, Michigan State University, East Lansing, Mich. 1949
CLARK, GORDON MARSTON—4223 Metzerott Rd., College Park, Md. 1957
Clark, Herbert C.—1005 Valley View, Allentown, Pa.

CLARK, TRUMAN B.—Department of Zoology, University of Minnesota, Minneapolis 14, Minn. 1952
CLOYD, WILL J.—Department of Biology, Carson-Newman College, Jefferson City, Tenn. 1949
CMEJLA, HOWARD E.—Research Division, Abbott Laboratories, North Chicago, Ill. 1954
COATNEY, G. ROBERT—Laboratory of Tropical Diseases, National Institutes of Health, Bethesda 14, Md. 1926
COIL, WILLIAM H.—Department of Zoology, University of Nebraska, Lincoln, Neb. 1950
COKER, COIT MCLEAN—Route 3, Box 62, Chapel Hill, N. C. 1954
COLEMAN, ROBERT M.—Department of Biology, Russell Sage College, Troy, N. Y. 1956
COLGLAZIER, MERLE L.—10513 Pinewood Court, Route No. 1, Adelphi, Md. 1949
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SCHWABE, CALVIN W.—Department of Parasitology, American University of Beirut, Beirut, Lebanon 1954
SCHWARTZ, ALBERT—Department of Biology, Albright College, Reading, Pa. 1954
Schwartz, Benjamin—Animal Disease & Parasite Research Branch, ARS, USDA, Beltsville, Md.
SCHWINK, THOMAS M.—Department of Zoology, Idaho State College, Pocatello, Idaho 1949
Scott, J. Allen—Department of Preventive Medicine, University of Texas Medical School, Galveston, Texas
SEAMSTER, AARON—Division of Science, Del Mar College, Corpus Christi, Texas 1939
SEITNER, PHILIP G.—1315 New Hampshire Ave., N.W., Washington 6, D. C. 1944
SELF, JOHN TEAGUE—Department of Zoology, University of Oklahoma, Norman, Okla. 1944
SEMRAD, JOSEPH E.—838 Grey Ave., Evanston, Ill. 1935
SEO, BYONG SEOL—Department of Parasitology, College of Medicine, Seoul National University, Seoul, Korea 1955
SENGER, CLYDE M.—Department of Zoology, Montana State University, Missoula, Mont. 1953
SENGBUSCH, HOWARD G.—State University College for Teachers, 1300 Elmwood Ave., Buffalo 22, N. Y. 1953

SHEFFIELD, HARLEY G.—14934 Hubbell, Detroit 27, Mich. 1956
SHOMAY, DAVID—Division of Biological Sciences, University of Illinois, Navy Pier, Chicago 11, Ill. 1950
SHORB, DOYS A.—Animal Disease & Parasite Research Branch, ARS, USDA, Beltsville, Md. 1929
SHORT, ROBERT BROWN—Department of Zoology, Florida State University, Tallahassee, Fla. 1946
SHUMARD, RAYMOND F.—Department of Veterinary Science, North Dakota Agricultural College, Fargo, N. D. 1953
SILLMAN, EMMANUEL ISAIAH—Department of Entomology and Zoology, Ontario Agricultural College, Guelph, Ontario, Canada 1947
SILVA, PENILDON—R. Libero Badaro-119, Sao Paulo, Brazil 1956
SILVERMAN, PAUL H.—Animal Diseases Research Association, Moredun Institute, Gilmerton, Edinburgh 9, Scotland 1957
SIMPSON, MYRON L.—1112 Bedford St., Cumberland, Md. 1942
SIMPSON, WILLIAM F.—Department of Biology, The Catholic University of America, Washington 17, D. C. 1944
SINDERMAN, CARL J.—Boothbay Harbor, Me. 1956
SINGER, IRA—The Rockefeller Institute for Medical Research, 66th St. & York Ave., New York 21, N. Y. 1952
SMALL, EUGENE B.—634 W. Kirby St., Detroit 2, Mich. 1956
SMITH, BARNETT F.—Spelman College, Atlanta, Ga. 1942
SMITH, CHARLES FRANCIS—104 W. Willow Rd., Prospect Heights, Ill. 1947
SMITH, PHILIP EDWARD—Department of Preventive Medicine & Public Health, University of Oklahoma School of Medicine, Oklahoma City 4, Okla. 1947
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Smith, Septima C.—Box 1386, University of Alabama, University, Ala.
SMITH, THEODORE A.—1846 Vassar Ave., Fresno 3, Calif. 1955
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WHARTON, GEORGE W.—University of Maryland, College Park, Md. 1935
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WILLIAMS, ROGER W.—Delamar Institute of Public Health, 600 West 168th St., New York, N. Y. 1944
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WILSON, NIXON A.—522 N. 3rd St., Bardstown, Ky. 1957
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WOKE, PAUL A.—Division of Tropical Diseases, National Institutes of Health, Bethesda 14, Md. 1933
WOLCOTT, GORDON B.—U. S. Public Health Service, P.O. Box 717, Columbia, S. C. 1949
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WORTHAM, RUBY A.—Department of Zoology, University of Idaho, Moscow, Idaho 1953
WRIGHT, WILLARD H.—Laboratory of Tropical Diseases, National Institutes of Health, Bethesda 14, Md. 1928
WU, LIANG-YU—Nematology Section, Science Service Bldg., Carling Ave., Ottawa, Canada 1954
WYANT, KATHLEEN D.—Department of Zoology & Entomology, University of Tennessee, Knoxville 16, Tenn. 1956

WYKOFF, DALE E.—Department of Tropical Medicine, 1430 Tulane Ave., New Orleans, La. 1950
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YAMAGUTI, SATYU—453, Tonodan Sakuragi-Cho, Kamikyo-Ku, Kyoto, Japan 1954
YARINSKY, ALLEN—Department of Parasitology, School of Public Health, University of North Carolina, Chapel Hill, N. C. 1952
YOKOGAWA, MUNEO—Department of Parasitology, School of Medicine, Chiba University, Chiba, Japan 1954
YOLLES, STANLEY F.—1802 Alberti Drive, Silver Spring, Md. 1945
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YOUNG, MARTIN D.—U. S. Public Health Service, Box 717, Columbia, S. C. 1936
YOUNG, VIOLA MAE—Department of Bacteriology, Army Medical Service Graduate School, Walter Reed Army Medical Center, Washington 12, D. C. 1944
YUNKER, CONRAD E.—NAMRU-3, c/o Postal Officer Box "E", APO 231 c/o P.M., New York, N. Y. 1953
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